OCTOBER 30, 1961

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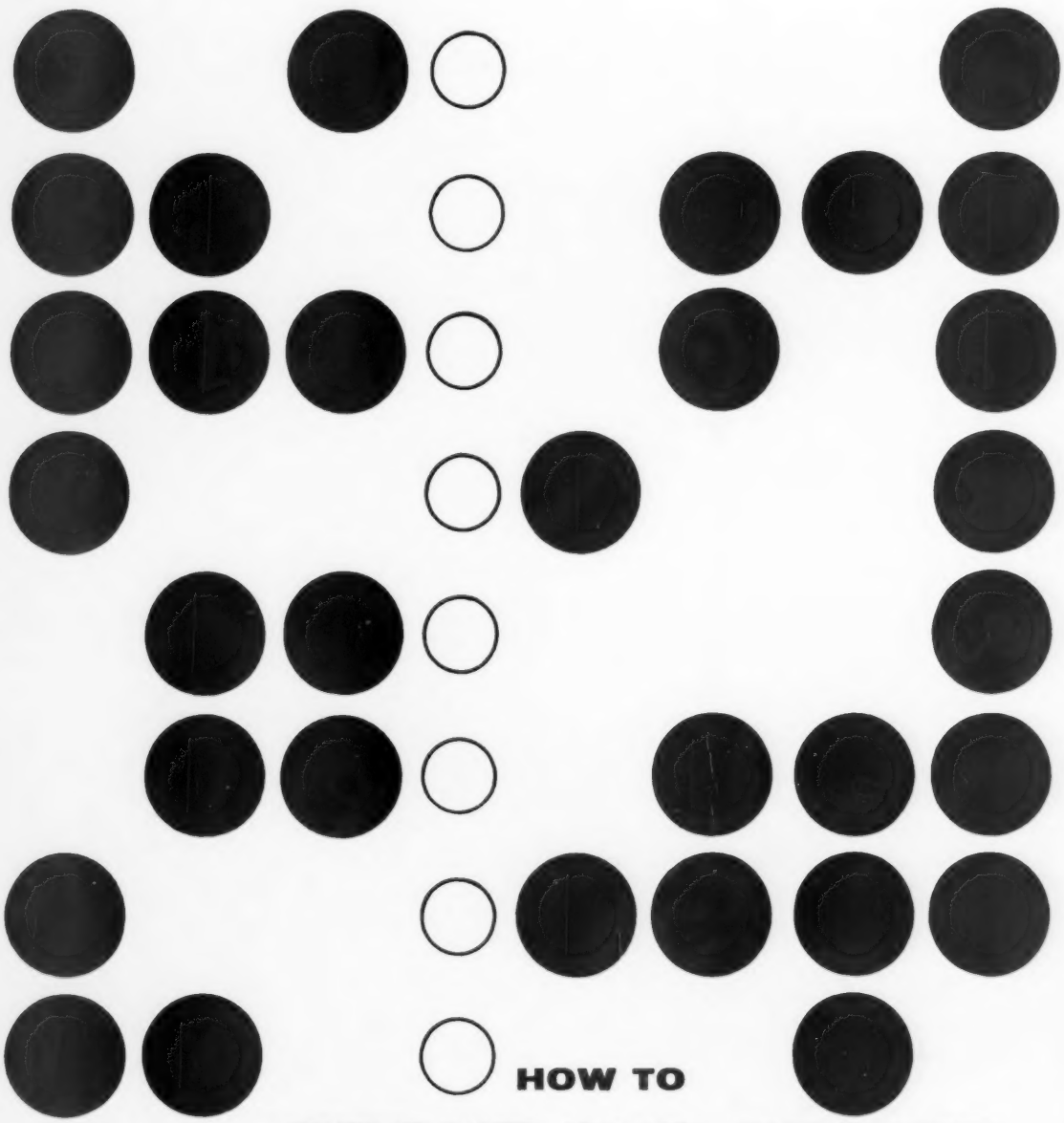


HOW TO PROVE THE PROFIT IN NUMERICAL CONTROL,

Special Report, Page 77

NUMERICALLY CONTROLLED DRILLING...

A short cut to a fast payoff

by Gordon Deagle
Engineer, Bore-Matic Division
The Heald Machine Company

Drilling has long been one of the simplest and most universally used operations in the machine tool field. Furthermore, of the various numerically controlled machines, the *drill* is one of the quickest to return its cost through resultant savings.

This is due largely to the fact that the increased accuracy required in most of today's drilling operations has heretofore been met by building expensive jigs and fixtures. And often these special fixtures have been made obsolete due to design changes long before they have repaid their cost through savings.

Many people think of numerical control only in terms of very high production. But with drilling this is not the case at all.

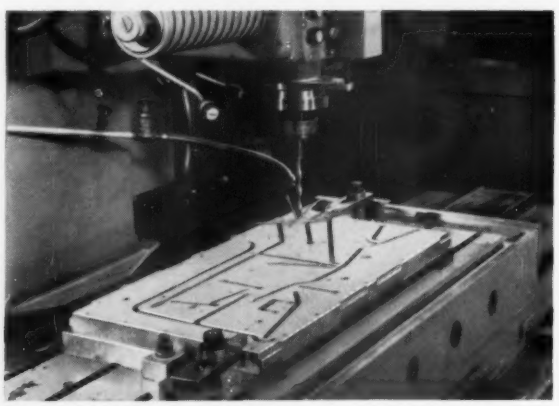
The HEALDRILL, a high-precision automatic tape-controlled drilling machine, has been profitably applied on many short run jobs involving frequent changeovers. In fact operating experience in our own drill department proves that the cost savings are even greater where small lots of many different parts are involved than on high production jobs where the expense of special jigs and fixtures might be recovered before obsolescence.

A case in point is the Heald hydraulic valve plate illustrated here in a setup on the machine. A mating pair of these plates forms a multi-channel valve panel which requires 54 drilled holes, 44 drilled and counterbored holes, and 75 holes that are drilled, reamed and tapped. All of these operations are now done on the numerically-controlled HEALDRILL and all cycle functions are fully automatic except for tool changes. Based on manufacturing in lots of 10, with a total of 200 before obsolescence of the part, the HEALDRILL method has saved $39.90 per panel over the jig method. This is a total saving of $7,980.00 on one job alone—almost 20% of the entire cost of the machine!

Hole positioning, feeds, speeds, rapid traverse and full depth limits, and drilling or tapping cycle are selected by the tape and hence are completely independent of the operator's skill, accuracy or speed. Tool changes, when required, are indicated by the machine and can be made in a matter of seconds. And total floor-to-floor time can be reduced by as much as 50 per cent. Changeover to another job requires no setup time except that required to insert a new tape in the control unit and locate the part on the table.

Preparation of the control tape for a new part is fast and relatively simple. With a HEALDRILL, sample and pilot lot production can be accomplished in days instead of weeks, and at minimum cost.

HEALDRILL in operation in drill department of The Heald Machine Company in Worcester, producing precision drilled, bored, counterbored, reamed and tapped parts for other Heald machines.



Hydraulic valve panels with 173 holes are precision drilled, counterbored and tapped on the HEALDRILL, at a saving of $39.90 per panel.

For complete information on the numerically-controlled HEALDRILL contact your Heald engineer—or send for a copy of Bulletin 2-20-48.

It Pays to come to Heald

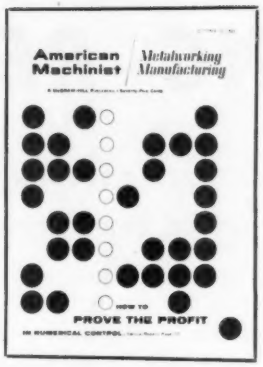
THE HEALD MACHINE COMPANY

Subsidiary of The Cincinnati Milling Machine Co.
Worcester 6, Massachusetts

CIRCLE 251 READER SERVICE CARD

COVER:

Design for this issue was created by Art Director Joe Poznanski. For some special comments on the significance of the design, see page 129.



American Machinist / Metalworking Manufacturing

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METALWORKING REPORT

. . . what's new and significant in manufacturing techniques and materials—direct from our own staff and round-the-world news bureaus

CHEMICAL MILLING . . . Parts with welded joints can be chemically milled without weakening the weld, even in cases where the welds are reduced to as little as 0.010 in. thick. In one application, grain size of a welded joint returned to nearly the original state after the area had been **reduced from a thickness of 0.050 in. to about 0.010 in.** Aerospace companies are now using this technique for milling molybdenum, tantalum, Inconel X, Inconel 718, tungsten, beryllium, and zirconium, as well as aluminum and stainless steels.

CUTTING . . . Feeds and speeds for machining tough alloys can be controlled by an electronic device called Dynatorque, which uses a computer to determine continuously the energy levels needed to remove chips and then **instantaneously adjusts the horsepower to that need.** A drillpress equipped with Dynatorque (made by Dynetics Inc, Torrance, Calif) drilled ninety 0.006-in.-dia holes a minute in ⅝-in. honeycomb, **getting 1000 holes per drill.** Without the device, rate was only a few holes a minute and tool life was 20 holes per drill. Device can also be used for sawing.

INSPECTION . . . Pipe mills can take a major step toward full automation with Baldwin-Lima-Hamilton's automatic weighing, measuring, and stenciling system that allows manufacturers to **hold closer to API nominal weight-per-foot specs.** For safety's sake, manufacturers have always leaned to the heavy side, and thus "gave away" tons of steel. These new systems, which take pipe up to 50 ft, 2 in. long and 10¾ in. dia, **measure its length to ±½ in., weigh it to within 0.1%,** then stencil this and other required data on the pipe. Operation takes 18 to 36 seconds per pipe.

MANUFACTURING CONTROL . . . Instant photos can replace engineering sketches on many machining-procedure sheets. One Midwestern plant takes Polaroid pictures of each machining setup, then pastes the pictures on job-instruction sheets to help machine operators understand their job assignments. **This practice has slashed time spent on engineering sketches by more than 60%.** Details on the technique will appear soon.

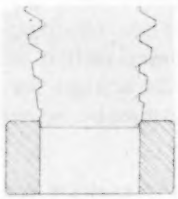
FINISHING . . . Plastic powders or ceramic enamel can be applied by an extension of the electrostatic paint-spraying technique with Starjet, a light hand gun and portable electrostatic generator that can also be built into automatic or production-line setups. Powders of 200 micron size and smaller can be put on and then heated to **form a smooth coating from 1 to 30 mils thick.** Because the electrostatic principle is used, coating is uniform on contours, in recesses, and corners. Device—which will spray thermo-plastics special insulations, decorative coatings—is distributed by Sames (NY, NY).

INSPECTION . . . Two new surface-measuring devices are about to be marketed by Micrometrical Mfg Co (Ann Arbor, Mich). One is a **precision 8-in. rotary table with 0.000,003 in. maximum runout** which can be set up with a tracer, stand, and amplifier/recorder to show surface roughness around IDs and ODs and on circular paths on horizontal flats. The other is an **extended-range Piloter** with a 15-in.-dia table.

472

MATERIALS . . . Mechanical properties of magnesium alloy castings, particularly AZ92, can be **increased by warm working,** according to Armour Research Foundation scientists. Castings are press forged in the solution-treated state. With deformations up to 20%, and a 400 F minimum forging temperature, **ultimate tensile strength of AZ92 was increased 19.5%; yield strength at 0.2% elongation increased 43%.** Yield strength of aluminum-alloy 220 was doubled, but elongation was reduced 50%.

CUTTING . . . By eliminating the critical Vee at the bottom of the tap form, Besly-Welles Corp (South Beloit, Ill) claims that their new standard tap **gets rid of a potential breaking point.** The new thread form (shown as solid line in sketch) clears any hole drilled for 85% of thread or less. (This will include 95% of all tapping applications that call for standard stocked tools, according to a recent survey.) The new form is said to be **particularly beneficial for hand-tool tapping.**



HEAT TREATING . . . New rotary retort furnace for carburizing and carbonitriding small parts, especially those that must be turned frequently for equal surface exposure, **has separate drives for tumbling and for feeding the work** through the retort. Prior designs made it hard to get tumbling without feeding parts through, and sometimes out of, the furnace. The Martin Duo-Drive furnace, developed by Varner Furnace Div of Joe Martin Co (Detroit) is fully automatic, and **can be used as a conventional shuffle-hearth furnace** (without the tumbling action) for clean hardening.

CUTTING . . . Repetitive machining to fine limits can be done by semi-skilled operators with a device called Micro-Guide by Paramatic Development, Ltd (Derby, Eng). Dimensions are sensed by a **probe which operates a rheostat wiper, feeding to an indicator panel with seven lamps.** Lowest (green) window is lit and a buzzer sounds at 0.025 in. from true size, and light remains on until machining reaches 0.005 in. from final dimension. From there, **each thousandth of change is marked by another amber window** until, at true size, the red window is lit. Over-run of 0.001 lights a blue window, sounds a bell.

FORMING . . . Magnetic-forming machines will soon be on the market. General Atomics Div of General Dynamics (San Diego) plans to market, on a lease basis, a machine capable of expanding and compressing parts as small as 1/16 in. dia by 1/16 in. long **or as large as 16 in. dia.** It can also be used for embossing, forming and blanking. **Called the Magnaform,** it will operate on 220 volts and use permanent coils. Lease terms: $6000 a year (1-yr minimum), or $600 a month (3-month minimum). For details on operation, and some typical applications, see *AM/MM*—Apr 3 '61, p99.

Continued on next page

Coming in AM/MM

- *Stainless steel can be chemical milled on a production basis*
- *When to centerless grind with a formed wheel*
- *Spark forming goes to work*

METALWORKING REPORT . . .

MANUFACTURING CONTROL . . . Inventory recording is automatic with a new device that "reads" perforated tags attached to parts. The inventory taker wheels the portable unit around, moving a tag-reading device from part to part. After general information (department number, dates) is recorded by throwing switches, **a sensing device—into which the employee inserts his badge—identifies the taker.** Builder is Parsons Corp.

WELDING . . . Noncorrosive fluxes that can be left in blind brazed structures, such as honeycomb, can be made by adding phosphate salts to normal fluoride and borate fluxes. When phosphate ions are in the flux, the protective coating that is formed **prevents deterioration of ferrous and nonferrous metals.** Murray Hill Research (Murray Hill, NJ) has applied for a patent on the process which they say **eliminates the need for special atmospheres and work cooling in honeycomb brazing.**

FILAMENT WINDING . . . N/C machine for missile fuel tank winding, claimed to be the first in this country, has been developed by Rohr Aircraft Corp in cooperation with Thompson Ramo Wooldridge. Engine cases wound of fiberglass filaments will lighten missiles. The machine is said to be a **first step toward a filament machine whose winding pattern is determined by computers, which in turn program the machine.**

FORMING . . . Special mechanical press, believed to be the largest of its type, has a four-point outer slide rated at 2000 tons and a single-point inner slide rated at 1000 tons. This pressure arrangement, just the reverse of the standard double-acting setup, is designed to **size and coin with the outer slide and cold extrude with the inner**—all in one operation. Press, which has a 54x60-in. blankholder and bolster plate, was built by Federal Warco Div of McKay Machine Co (Youngstown, Ohio).

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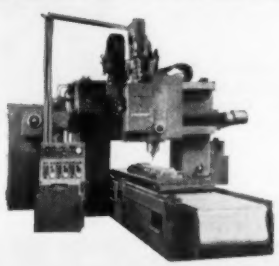
MAKES PROFIT MORE PREDICTABLE

More and more companies are experiencing miracles in metalworking. These miracles have been accomplished through a new generation of machine tools . . . machine tools which perform "impossible" operations, while divorcing high costs from small lots to make profit more predictable than ever before.

The most outstanding miracles in metalworking are accomplished on Cincinnati Milling's new generation of numerically controlled machine tools, including the new Bridge-Type Profile and Contour Milling Machine illustrated here. This machine is equipped for 3-axis control: table feed, cross feed of spindle carrier, and vertical feed of spindle carrier. And, for 4-axis control it can also be equipped with angular feed of spindle carrier.

Cincinnati's ACRAMATIC 3-Axis Numerical Control System gives these machines an additional value for producing variety work at minimum cost. For example, the system permits complete manual control of slides, prior to program control, with finger-tip actuated Telephase handwheels, readout dials and counters . . . feed rate override ranges from 0 to 100% of programmed feed . . . exclusive cutter diameter compensation eliminates reprogramming for cutters within ± 1" of programmed size. Now turn the page and see a real revelation in CINCINNATI Numerically Controlled Milling Machine performance. **Special Machine Division, The Cincinnati Milling Machine Co., Cincinnati 9, Ohio.**

Contoured pockets are automatically milled in aircraft wing inner panel beams, on this CINCINNATI Numerically Controlled 36" x 120" Bridge Type Profile and Contour Milling Machine. Available in 24", 36" and 48" table widths, and table travel from 48" and up. Catalog M-2090-2.



CINCINNATI®

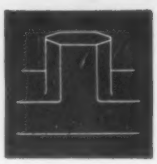
SPECIAL MACHINE DIVISION

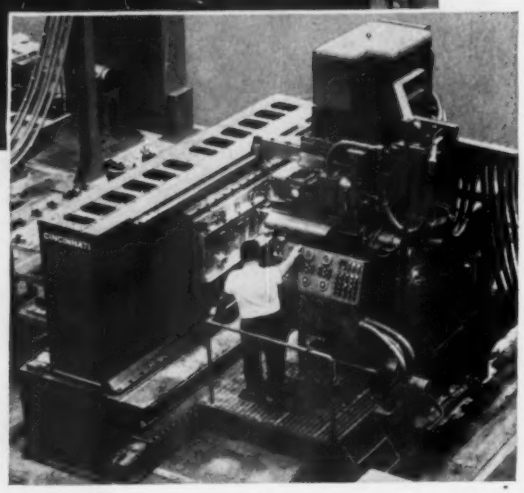
DESIGNERS AND BUILDERS OF

SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES • COMPLETE PRODUCTION LINES

Photo courtesy Rocketdyne, a division of North American Aviation, Inc.

Above: **90% saving in time** for the operation of milling sixteen lugs from the solid in rocket engine injectors. The machine performing this operation is a CINCINNATI Traveling Column Numerically Controlled Miller. Drawing of lug is shown at right.





Right: **Three-dimensional machining** operations on intricate right and left-hand parts proceed automatically on the CINCINNATI Traveling Column Numerically Controlled Milling Machine illustrated here.

DESIGNERS AND BUILDERS OF SPECIAL MACHINES • HORIZONTAL BROACHING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

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Reduces a Week's Machining Time to 3½ HOURS...

Just imagine... a multiple operation milling job which formerly required a week to complete, is now finished far more accurately in 3½ hours... just 1/10 the previous time.

The part is a large rocket engine injector. Ninety-six milling operations are numerically controlled, completed in one program which required only 4 hours to prepare.

This cost-shattering record is compiled by the CINCINNATI Numerically Controlled Traveling Column Milling Machine illustrated on the opposite page. What's the secret of Cincinnati N/C milling performance? It will be found in the skillful integration of machine and controls.

Cincinnati Special Machine Division engineers are well acquainted with design requirements for numerically controlled machine tools. These men know full well that the finest controls can perform no better than the machine. Extra attention is given to slideway bearing lubrication (no stick-slip allowed); more precise feed drive parts; extra rigidity throughout; ultra responsive servo drive; elimination of backlash and friction.

The numerical control system is the finest available; it's CINCINNATI ACRAMATIC, a product of Cincinnati's new CIMTROL Division. Many similar types of numerically controlled machines have been built by Cincinnati Milling. All are considered as completely integrated production units, ready to go to work at their jobs of reducing costs. Our Specialists will gladly show you how this type of equipment can help you, too.

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Both models set up fast and are easy to handle. Work areas are easily accessible. Automatic retraction of table from hob facilitates work changes. Advanced design provides pushbutton hob shifting, built-in hydraulics for operation of tailstock and fixtures, and infinitely variable speeds and feeds. Construction is solid and rugged throughout.

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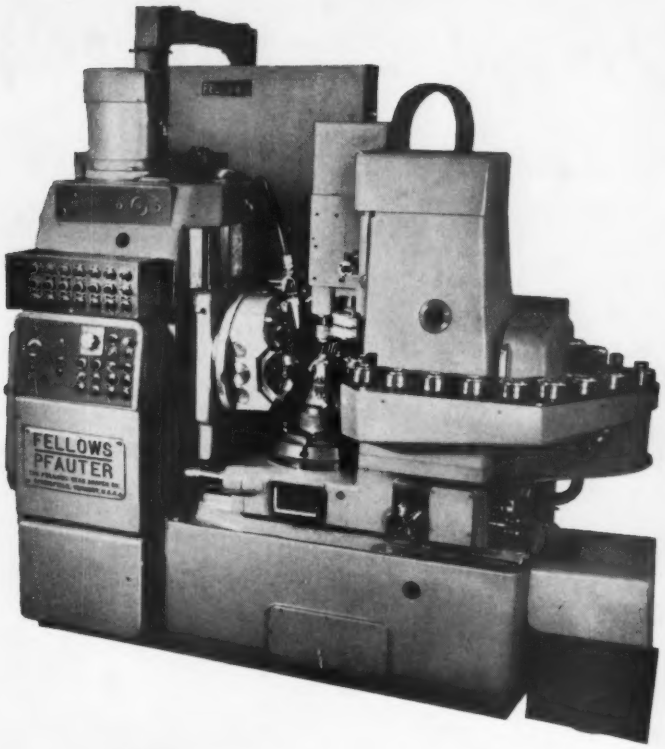
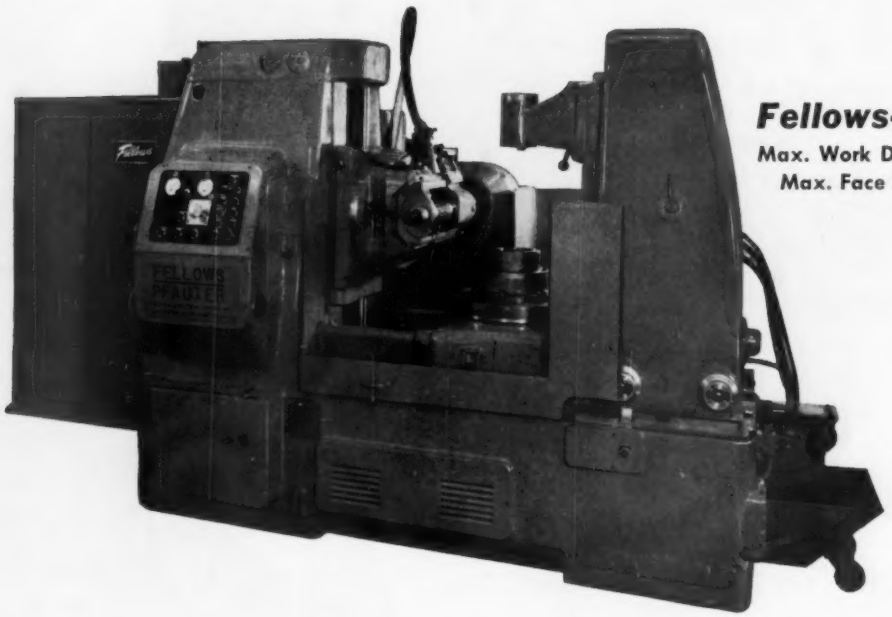


Fellows-Pfauter P400

Max. Work Dia. — 16″; Max. D.P. — 4;
Max. Face Width — 11″ at 16″ dia.;
Hob R.P.M. — 80-500.



Fellows-Pfauter P630

Max. Work Dia. — 25″; Max. D.P. — 3;
Max. Face Width — 16¼″ at 25″ dia.;
Hob R.P.M. — 62-390.

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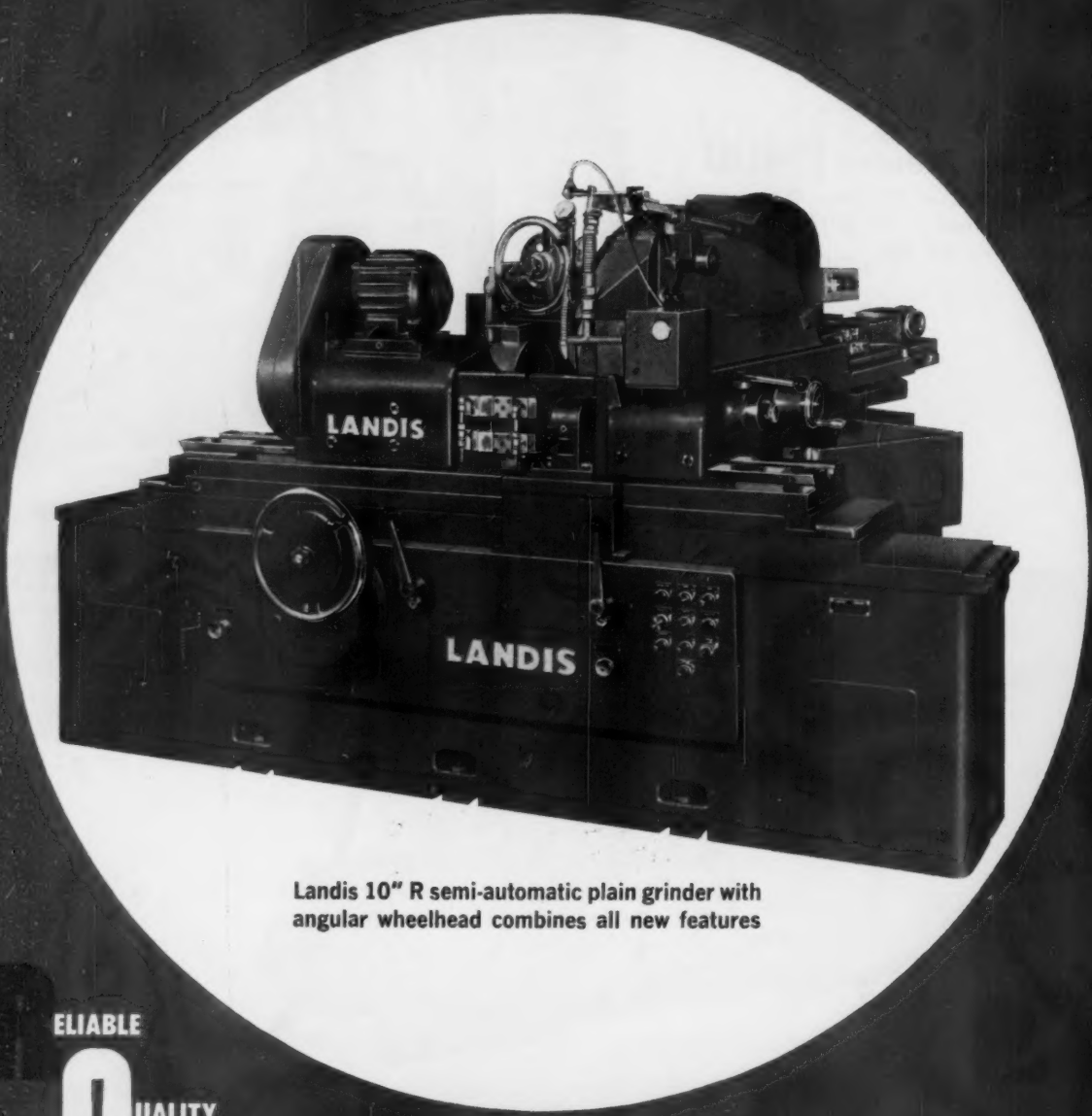
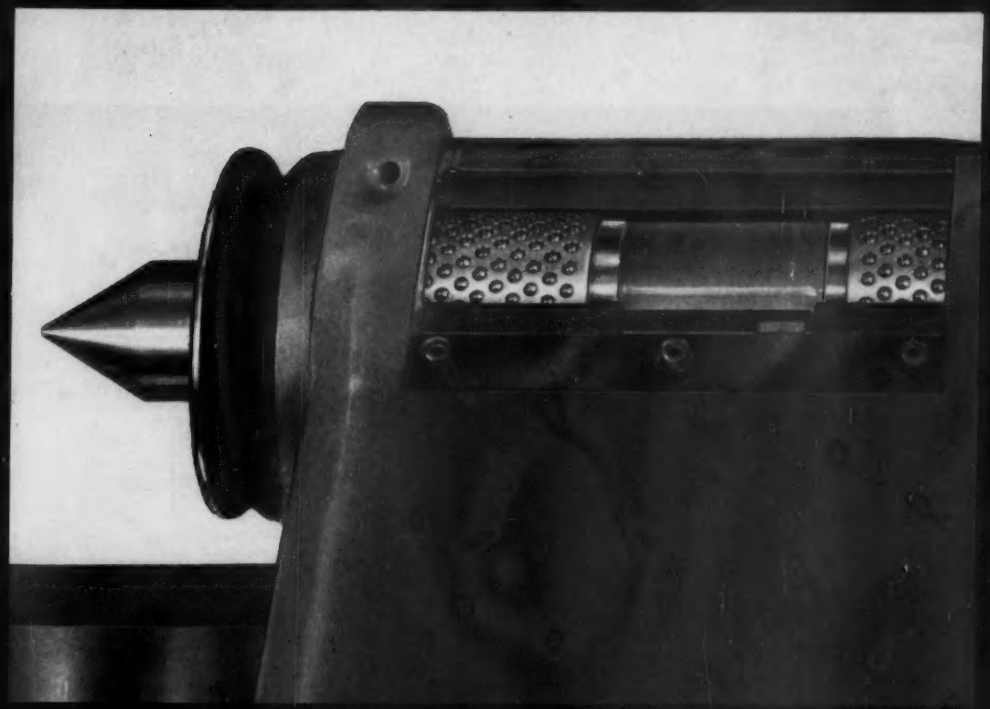
Exclusive Landis reliability features lower unit grinding costs



Landis 10" R semi-automatic plain grinder with angular wheelhead combines all new features

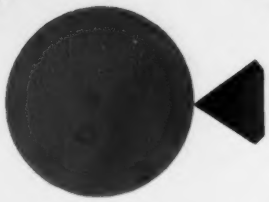
RELIABLE QUALITY PRODUCTION

THE EFFICIENCY of a modern cylindrical grinder is based on its capacity to do a more precise job–and do it consistently. Landis designers have produced these machines with a **combination** of important features built around four major essentials: **work support, wheel support, wheelfeed** and **wheel dressing.**



Work support. Exclusive ball spindle footstock is assembled under preload. Eliminates adjustments for clearance or wear, assures maximum rigidity to work parts. (cutaway view)

Wheel support. Exclusive Microsphere wheel spindle bearing reduces sparkout time, speeds production.

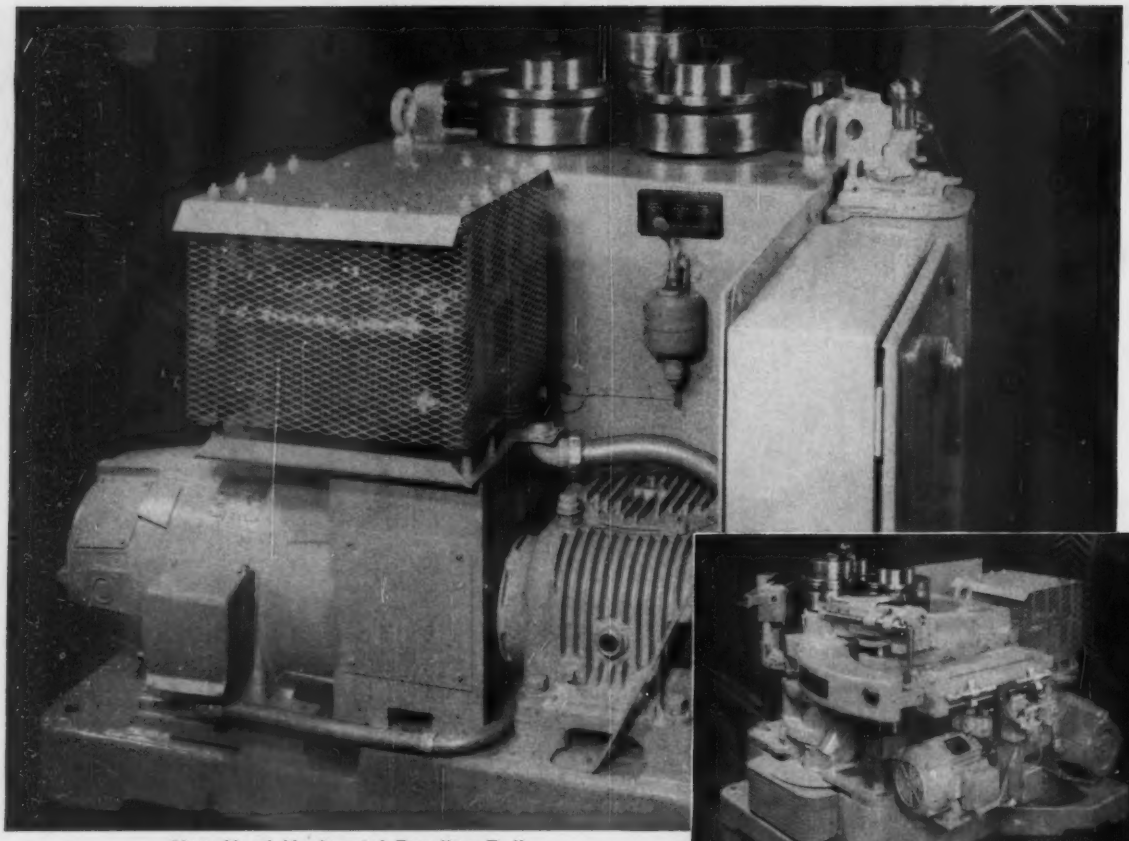


Wheel dressing. Exclusive Landis Truform dresser with ball slide, shake-free construction. Assures exact duplication of all wheel profiles.

Wheelfeed. Exclusive Landis Microfeed® is a pulse feed in millionths to final size that meets closest tolerances on a production basis.

LANDIS

LANDIS TOOL COMPANY, WAYNESBORO, PA.



New No. 1 Horizontal Bending Roll

Note Hydraulic Roll Adjustment

SPEED DIE-LESS COLD METAL BENDING WITH IMPROVED 'BUFFALO' BENDING ROLLS

- *Fast* Production Bending of Circles, Arcs and Spirals to Commercial Accuracy.
- *Hydraulic* Roll Adjustment Speeds Setup Time.
- *New,* Compact Design Saves Valuable Floor Space.
- *Handle* Angles, Rounds, Squares, Tubes, Pipes, Flats and Special Shapes.
- *Easily* Changed Rolls Eliminate Need for Expensive Dies.
- *Models* and Sizes to Handle All Types of Work.

Improved 'Buffalo' Bending Rolls are engineered for peak accuracy. Rugged construction insures long, trouble-free life. Optional attachments available.

See how 'Buffalo' Bending Rolls can save you production and maintenance time and money. For complete facts, contact your 'Buffalo' machine tool dealer or write the factory direct.

ESTABLISHED 1877 "Buffalo" MEMBER N.M.T.B.A.

MACHINE TOOL DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

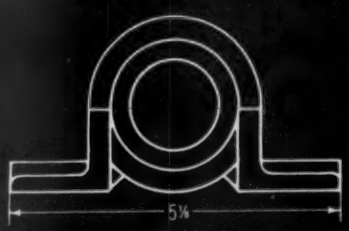
'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

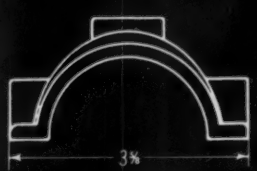
NEWEST SINGLE SURFACE DISC GRINDER

Greater rigidity of new Gardner 1H20 results in improved precision and reliability at high production rates

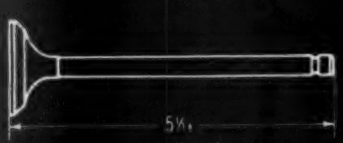
disc grinds parts like these



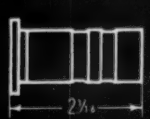
pillow block bearing



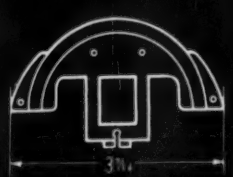
connecting rod cap



automotive valve



valve tappet



typewriter part

This new disc grinder has a 23" disc and can be equipped with 10, 15 or 20 hp spindle drive motors. Manual or automatic loading.

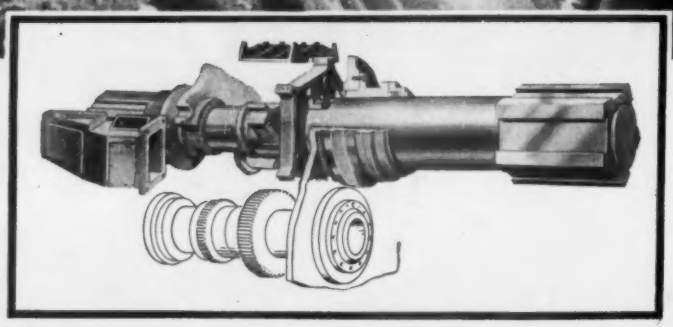
GARDNER

precision disc grinders

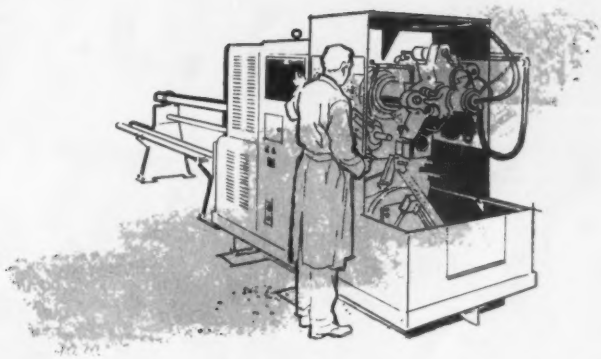
GARDNER MACHINE COMPANY, BELOIT, WISCONSIN

a subsidiary of Landis Tool Company

The secret of precision finishing on automatics lies strongly in customer "know-how". Good machine design also helps. For example, the massive 2AB Pentagon Turret is located overhead, away from accuracy-destroying grit, and coolant splash. For lasting accuracy, turret and spindle bearings are ruggedly built and housed within the same temperature zone to insure stability under operation.



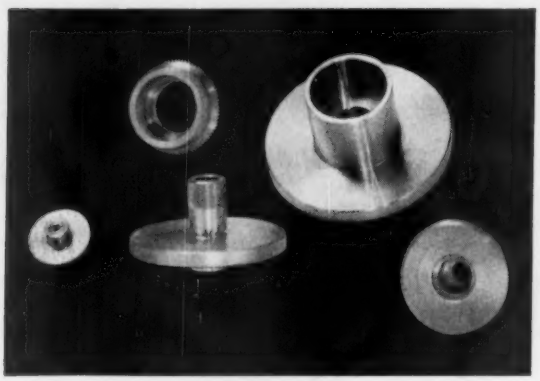
AT ARCH GEAR WORKS, INC.
Quincy, Mass.



3" Bar Automatic produces stainless gears with .0005" tolerances and 16 rms finishes

Contract shop stays highly competitive with elimination of extra finishing operations, low tool costs, 3 to 4-hour setups.

By using a Warner & Swasey 2AB Single Spindle Bar Automatic for small lot precision gear work, Arch Gear Works has eliminated secondary finishing operations.



75% of Arch Gear's precision parts are stainless steel. The 2AB produces jobs like these 3 times faster than turret lathes, and eliminates the extra finishing operations as a bonus.

Tooling costs are at rock-bottom, with the 2AB utilizing simple cutter bits in its multiple-position tool stations. The cost of cams is eliminated by controlling feeds, speeds, turret strokes and other motions with easy-to-set trip dogs.

Since they can set up their 2AB in 3 to 4 hours, Arch Gear Works is automating lots as low as 150 pieces—jobs formerly considered profitable only on hand-operated machines.

No wonder this New England concern bids successfully on jobs it may never see again. If you are bidding high on similar work, why not get the facts on the 2AB? Call your local Warner & Swasey Office, or write Warner & Swasey Company, Cleveland 3, Ohio.

YOU CAN TURN IT BETTER, FASTER, FOR LESS...WITH A WARNER & SWASEY

WARNER & SWASEY

CIRCLE 264 READER SERVICE CARD

New IBM computer language...AUTOPROMT cuts milling time for this helicopter gearbox cover by 75%

AUTOPROMT (AUTOmatic PROgramming for Machine Tools) is a powerful new computer language designed to broaden the use of numerically-controlled machine tools.

AUTOPROMT, for the first time, lets an engineer *describe the surfaces* of the three-dimensional shape he wants milled, *rather than calculating every path* the tool must follow in order to machine the part.

AUTOPROMT leaves to the computer the task of automatically generating these tool paths. You describe the part to be milled and the tool to be used in simple, *English-like*

terms. The computer does the laborious calculating work.

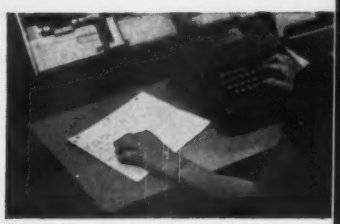
AUTOPROMT produces results like these: the time to mill the gearbox shown in the photographs cut to *one-fourth* the machine time required by conventional methods. AUTOPROMT reduced the lead time from blueprint to production *from three months to two weeks.*

AUTOPROMT is available to IBM customers. Call your local IBM Representative for complete details on this latest advance in Numerical Control of machine tools.

IBM®
DATA PROCESSING

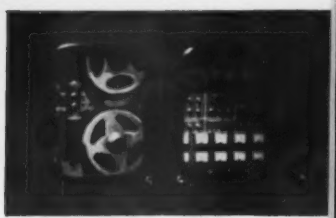
Here's the way AUTOPROMT works at United Aircraft Corporation

The Parts Programmer, using a conventional blueprint, prepares 180 one-line statements in AUTOPROMT language.



The statements are punched into standard IBM cards and entered into the IBM 7090 Data Processing System. (AUTOPROMT also works with the 704 and 709 Systems).

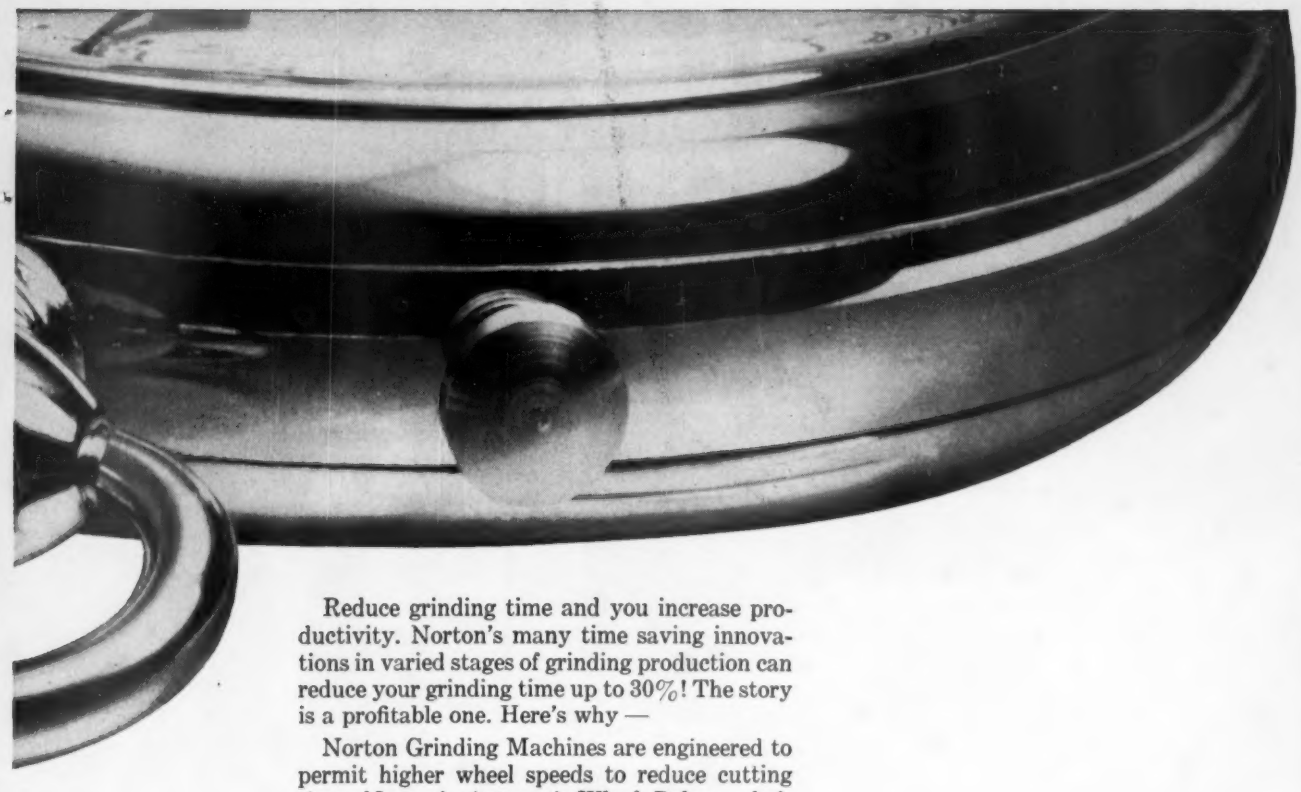
The 7090, programmed with AUTOPROMT, produces 8000 tool path instructions needed to direct the Pratt and Whitney Co. Inc. Numeric-Keller Continuous Path Milling Machine.



Punched tapes direct the Numeric-Keller Milling Machine.

The Numeric-Keller mills the helicopter gearbox cover.

Time is the measure of productivity



Reduce grinding time and you increase productivity. Norton's many time saving innovations in varied stages of grinding production can reduce your grinding time up to 30%! The story is a profitable one. Here's why —

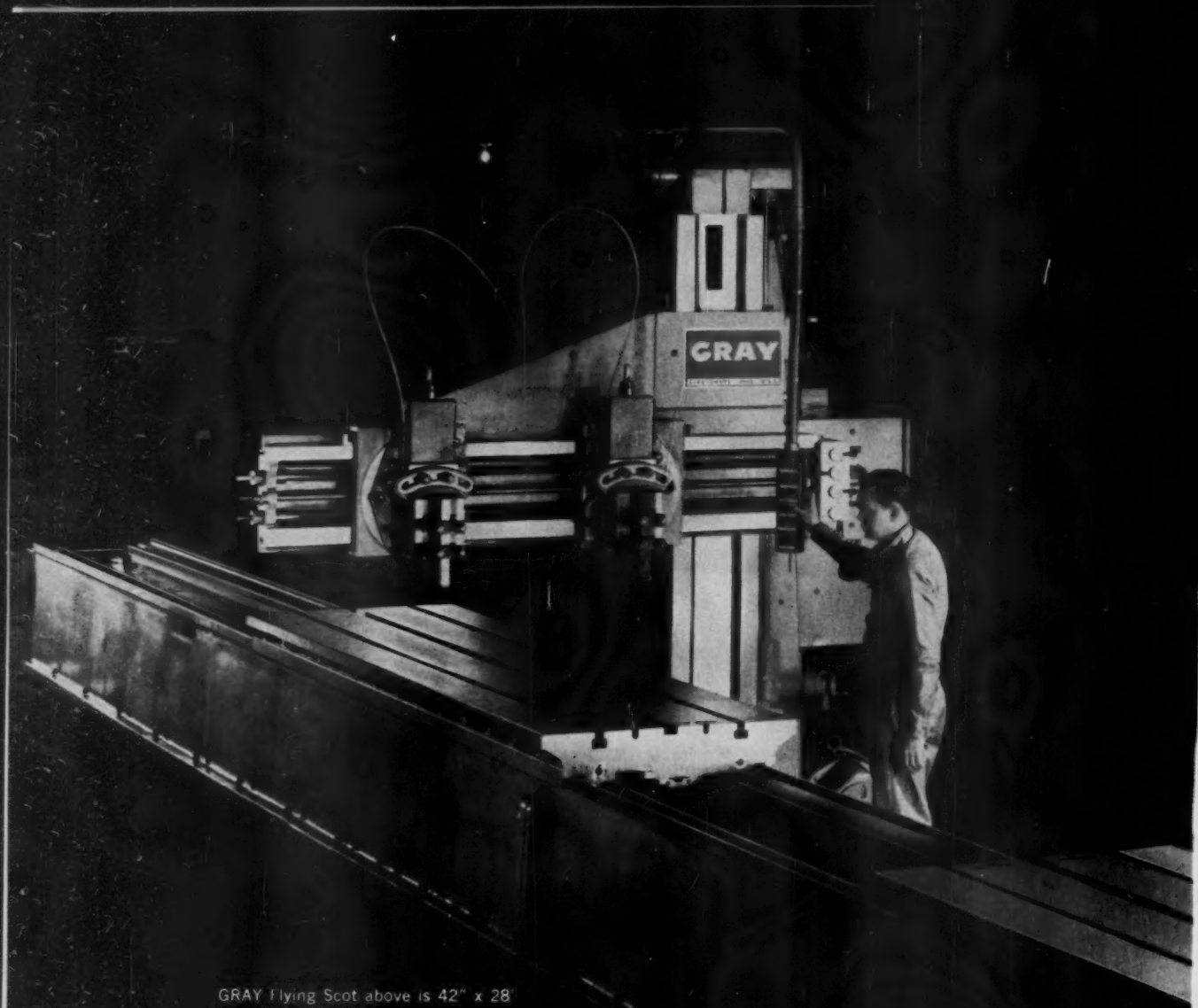
Norton Grinding Machines are engineered to permit higher wheel speeds to reduce cutting time. Norton's *Automatic Wheel Balancer* balances the wheel in *five seconds — on the machine.* You reduce time spent "grinding air" up to 85% because of Norton's *Automatic Wheel Contact Accelerator* which speeds the wheel to the work and compensates for work piece-diameter variation. Another advance is Norton's *Automatic Truing* which eliminates work interruptions and the *Automatic Wheel Wear Compensator* that stabilizes the grinding cycle.

Norton Grinders further add to your productivity by minimizing work spoilage with *Automatic In-Process Gaging.* In the case of surface grinders Norton *Higher Table Speed of 150 fpm* actually reduces grinding time up to 50%.

These are only some of the many reasons you can increase your productivity with Norton Grinders. They also offer accessories that literally transfer skills to machines — *ultra-fine feed,* and *automatic features* such as *steady resting, endwise locating, loading, constant peripheral wheel speed* and *hydraulically-operated feed screws* provide this competitive advantage.

The decision is yours — can you afford not to reduce the time it takes to produce your product? Can you afford not to increase your productivity? Contact your Norton man, NORTON COMPANY, Machine Tool Division, Worcester 6, Mass. District Offices: Worcester, Hartford, Cleveland, Chicago, Detroit. In Canada: J. H. Ryder Machinery Co. Ltd., Toronto 5.

NORTON
MACHINE TOOLS
... Making better products to make your products better



GRAY Flying Scot above is 42" x 28'
with two rail heads
and special duplex table.

26 page Bulletin No. 73
on GRAY Flying Scot
available
on request

The G. A. Gray Co. / Cincinnati / Ohio /

What makes the $30,660* GRAY a best seller?

The 30"—36"—42" GRAY Flying Scot can lick any planer its size, in price or performance. It packs more value per dollar than any planer ever built. It is perfectly constructed, down to the smallest component, exactly like every Gray machine. It will perform — precisely — for years. Carbide planing up to 300 ft. per minute makes it the world's highest production small planer. Optional features, like double cutting and a duplex table, increase its productivity — and your hourly profit. Over 15 have been purchased since first introduced in May 1960.

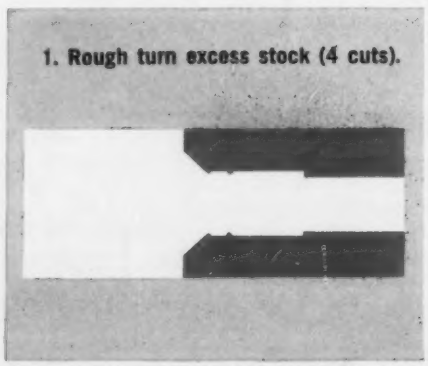
*Basic price of 30" x 6' Flying Scot one rail head, electric drive, and controls.

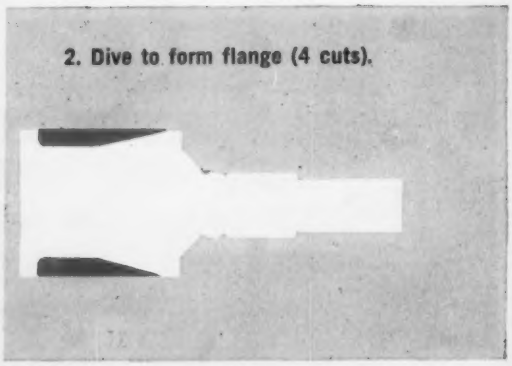
horizontal milling and boring machines / planers / milling planers

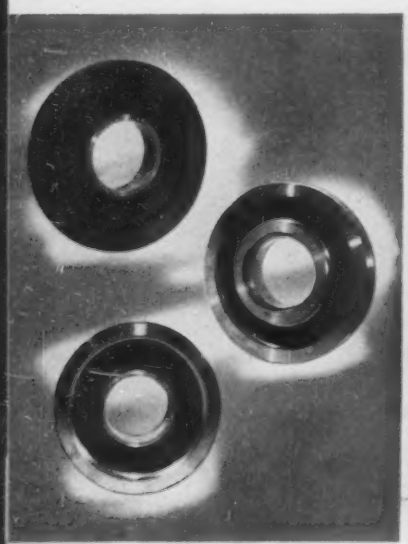
RIGHT NOW!

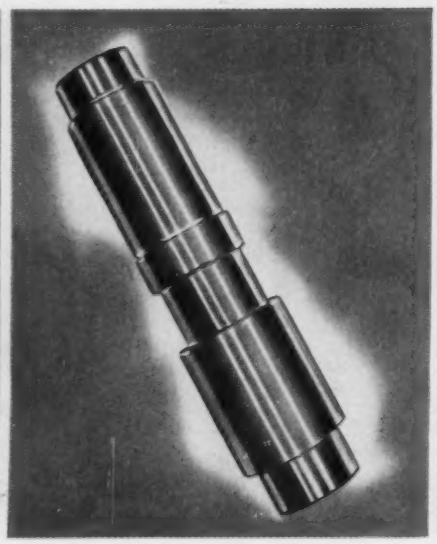
1 COMPRESSOR SHAFT

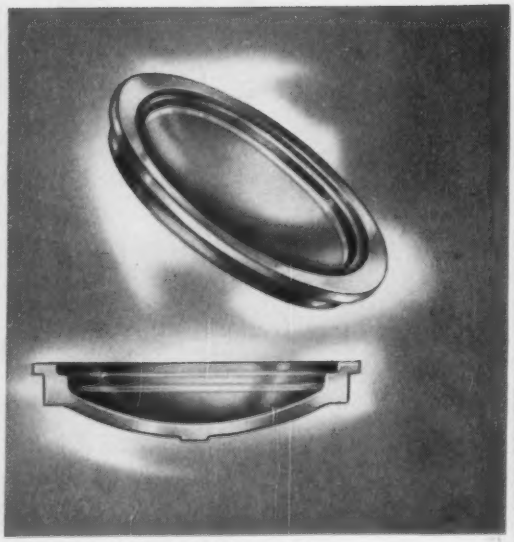
There are five operations involved in turning this part. Areas outlined in color in illustrations at right show metal removal in each operation. Handling this job on the Monarch Pathfinder Controlled Lathe results in 72% savings over the former method. Principally, these savings are obtained through the use of multiple cuts programmed to give an automatic cycle. A variety of tools and carbide grades are used in the turret to provide the best cutting action for each individual cut. Speeds and feeds are tape selected for each diameter change.











2 GEAR BLANK

Material SAE-5150. Face Hub, Turn OD, Machine ID Web. Reverse Part, Turn Taper, Bore, Form Radius and Relief.

Method	Set-Up	Turn R.E.	Turn L.E.	Total 30 Parts	% Savings
Chucker	300 min.	3.5 min.	5.7 min.	576 min.	61%
N.C.	24 min.	3.5 min.	3.1 min.	222 min.	

3 PINION SHAFT

Material AISI-4145 Stock. Rough Turn, Undercut, Groove (2 diameters).

Method	Set-Up	Machining	Total 10 Parts	% Savings
Tracer	101 min.	13.9 min.	240 min.	68%
N.C.	12.5 min.	6.5 min.	77 min.	

4 INJECTOR RING

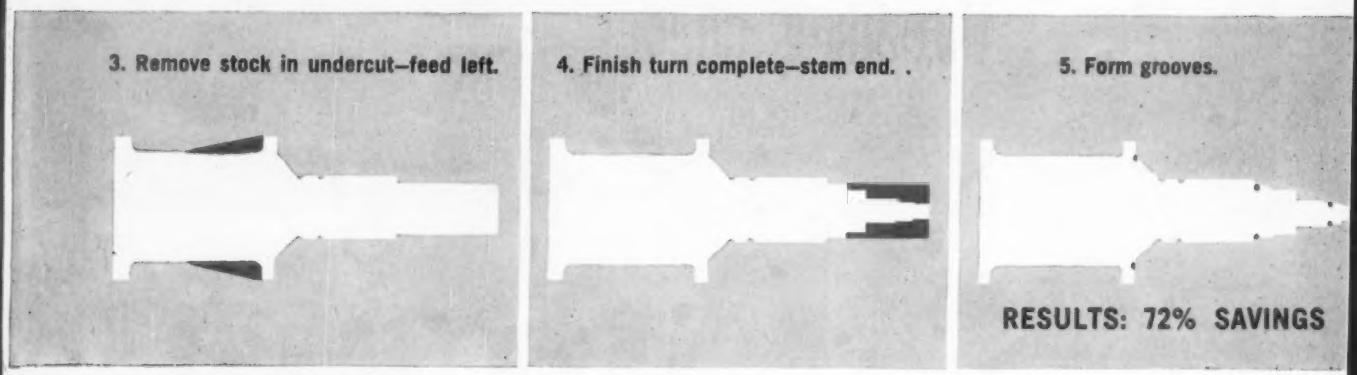
Material 347 Stainless. Face and Turn OD, Bore ID Hub and Taper, Turn 18-inch Spherical Radius.

Method	Set-Up	Machining	Total 6 Parts	% Savings
Tracer	130 min.	290 min.	1870 min.	77%
N.C.	16 min.	70 min.	436 min.	

◀ CIRCLE 270 READER SERVICE CARD

▲ CIRCLE 271 READER SERVICE CARD

MONARCH PATHFINDER CONTROLLED LATHES ARE SUCCESSFULLY TURNING PRODUCTION PARTS AT CUSTOMERS' PLANTS WITH CONTINUOUS PATH NUMERICAL CONTROL



Here are four examples of what can be done with Monarch Lathes "mated" with Pathfinder Numerical Controls. In each case a continuous smooth contour is produced by the numerical data which controls the tool path, distance and feed rate.

Why do we say "mated"? There are two important reasons why the machine control must be "mated" or "properly matched" by the machine tool builder to the specific requirements of the job. First, response of the control must be such that the machining capacity of the lathe is not limited. Second, accuracy of the lathe must be such that the full accuracy of the control is realized. Sounds academic, but these production examples prove it.

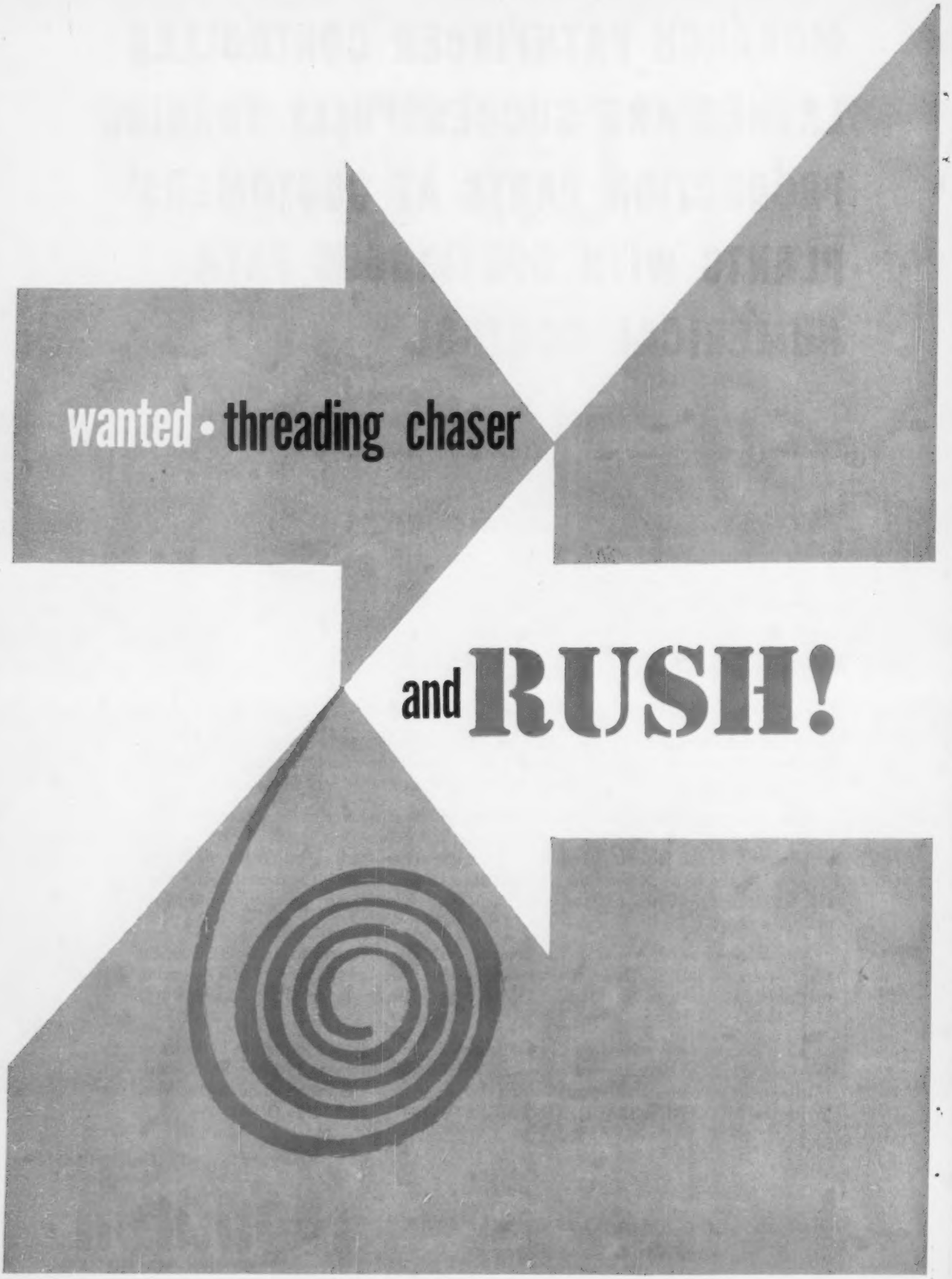
Monarch uses either one of several commercially available continuous path numerical controls on its lathes. These controls are "mated" at our factory to the following machines: Model 2013-16; Model 2516-20 Heavy Duty; Model 3220 Heavy Duty; and Model 4025 Heavy Duty.

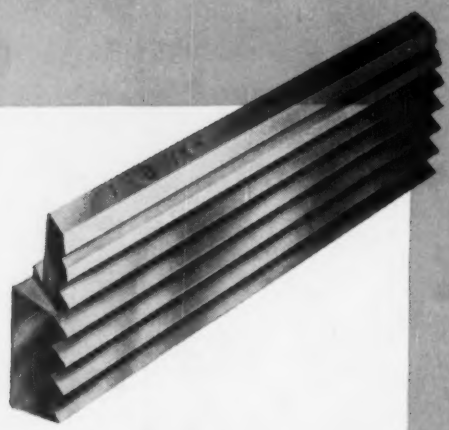
When do you need a Numerically Controlled Lathe? Now is the time to investigate. Why not ask us to evaluate and review your turning requirements? Monarch's Numerical Control Department offers application planning, personnel training and field service. Write the MONARCH MACHINE TOOL COMPANY, SIDNEY, OHIO.

Ask about the Monarch Deferred Payment and Tool Lease Plans

Monarch
TURNING MACHINES
ACCURACY • ECONOMY • LONG LIFE
FOR A GOOD TURN FASTER . . . TURN TO MONARCH

CIRCLE 272 READER SERVICE CARD


wanted • threading chaser
and RUSH!



There are threading chasers and there are threading chasers. But, there is one chaser which is better in several ways—right down to arriving in your plant on time from a rush order. It is the Landis Tangential Chaser, pioneered and introduced by the Landis Machine Co. It's better for these reasons:

1. *DELIVERY*—As good as the best; better than most. Landis maintains a large inventory of chasers in standard forms. As a result, rush orders on standard chasers are shipped within a few hours after the order is received. Standard chasers, for regular orders, are shipped the next day.

2. *INTERCHANGEABILITY*—Because Landis includes the helix angles in the chaser holder and not in the chaser, we are able to offer interchangeability. You do not need a set of chasers for each diameter you want to cut. As long as they are used within the wide range of the chaser holder, each set of chasers is interchangeable between different sizes and styles of die heads. This reduces your investment in chasers and keeps your inventory low. Interchangeability keeps your job running, too.

3. *UNIFORMITY AND QUALITY*—*All* Landis Chasers undergo a stern quality control routine. *All* of the same type are manufactured the same way and *all* are heat-treated in the same manner. Furthermore, Landis Chasers are often given special hardening treatment when workpiece design or material specifications so indicate. The ability to determine and apply the proper chaser hardening technique is the result of our over 55 years experience in a single field —THREADING. Quality also applies to the full complement of Landis Die Heads available with Landis Chasers.

4. *NO JOB TOO TOUGH*—We will tackle any threading job. Quite often Landis Chasers are chosen because competitive chasers cannot do the job. Landis Chasers have been proved successful on about every thread form there is—even Acme threads on large diameters!

5. *COST*—Landis Chasers are very competitive. In dollars and cents most competitive chasers will meet the Landis price, but when quality and tool life are taken into consideration the Landis Chaser will be chosen. Landis Chasers are better. Buy now and prove it to yourself.

LANDIS *Machine* COMPANY
WAYNESBORO • PENNSYLVANIA
THE WORLD'S LARGEST MANUFACTURER OF THREADING EQUIPMENT

619C

LEBLOND
LEBLOND
LEBLOND
LEBLOND

First from LeBlond Continuous-Path Tape Controlled Lathes

Talk to LeBlond about Tape-Turn lathes. You'll be talking about machines we've got on the run off floor rather than on the drawing board. We're delivering at least six months ahead of competition. Our experience can help you get an important edge on *your* competition.

Tape-Turn is being built with 20 to 75 hp in sizes from 2013 to 4025.

100% tape commanded by G. E. Mark Century control—*all* operator controls at the console—solid state components (no tubes, stepping switches or rotating parts)—temperature and humidity controlled—built-in computer for linear and circular interpolation.

Benefits

Increased efficiency and management control, reduced lead time, a permanent record in easily-stored form, low-cost quality control, reduced parts inventory, shorter set-up time and lower tooling costs.

Ask to have a LeBlond field engineer stop and talk Tape-Turn, the machine on the floor instead of the drawing board. Or write for our new descriptive bulletin TT-1061 A.

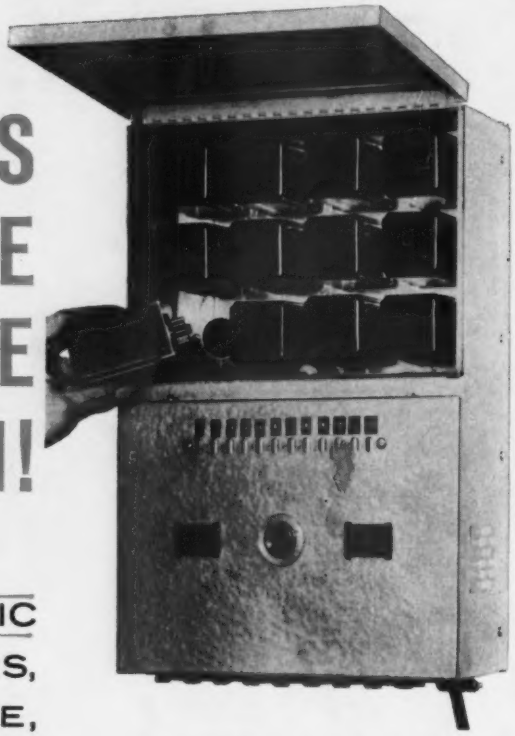
The R. K. LeBlond Machine Tool Company
Cincinnati 8, Ohio

Leading the way in numerically-controlled turning.

LEBLOND of Cincinnati

CIRCLE 276 READER SERVICE CARD

NEW CONTROL STOPS AUTOMATIC MACHINE OPERATIONS IN CASE OF MALFUNCTION!



TRANSISTORIZED SENSOMATIC CONTROL SAVES MAN HOURS, PREVENTS MATERIAL WASTE, MACHINE AND TOOL DAMAGE

Newark, N. J.: A new line of transistorized controls called Sensomatic has been developed by Weldotron Corporation. Sensomatic is a low-cost, easy-to-install digital control for monitoring automatic machine operations. It will stop the machine immediately upon detecting malfunctions such as misfeed, improper positioning or improper parts transfer, buckling, end of material, etc., thus preventing tool and machine damage and material waste. Add to this the savings in man-hours and the fact that faster operation is possible because it reacts quickly, and it is easy to see why Sensomatic will surely cut costs in your automatic machine operations.

Sensomatic is ruggedly constructed with no moving parts in operation. It requires little power and features fail-safe, dust free circuitry encapsulated in epoxy resin for maximum resistance to shock, moisture and other detrimental environmental conditions.

Proven performance

For some time many large manufacturing companies such as Scovill Mfg. have been using Sensomatic units in actual production operations. Records have proven the success of the units.

Sensomatic controls are available in several models. To learn which model is best suited to your operations, please write today to Weldotron Corporation, 911 Frelinghuysen Avenue, Newark 14. N. J.

SENSOMATIC Model 1200 Will Monitor Operations of up to 12 Stations

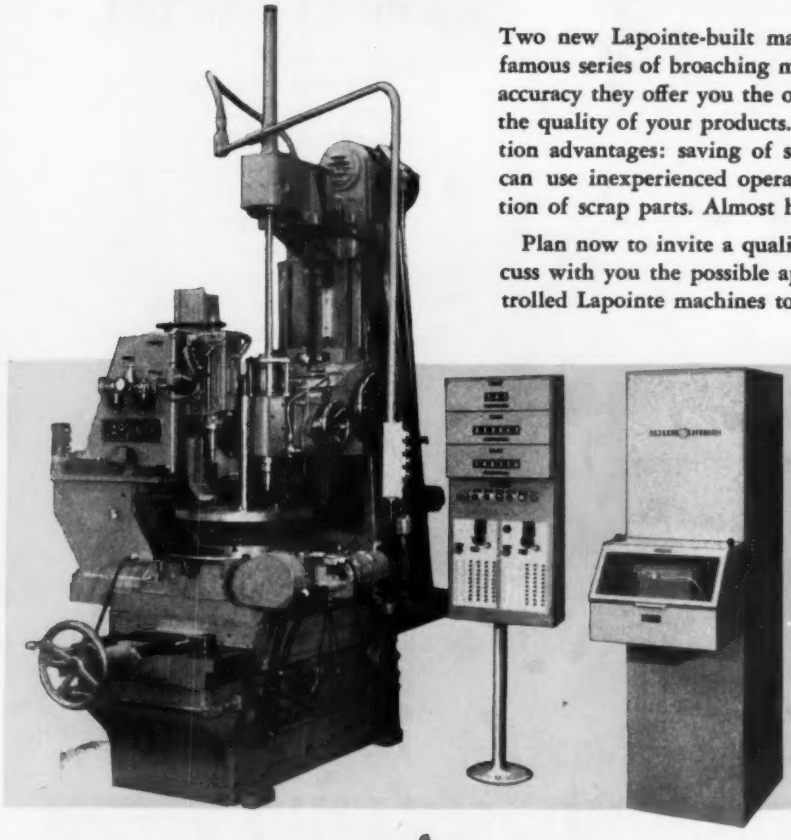
The Sensomatic 1200 Multi-Station Detector will monitor operations of up to 12 stations. If a malfunction occurs at any one station, the machine is instantly stopped and a visual signal alerts the supervisor. The exact location of the trouble is pinpointed by individual indicator lights.

The 1200 is supplied with 4 modules but eight others may be added as requirements increase. Economical use of the modules is possible because they are interchangeable on all Model 1200's.

WHERE SENSOMATIC CONTROLS CAN BE USED

Waterbury Farrell and Baird Eyelet Presses • Punch Presses • Press Brakes • Shears • Forging Machines Die Casting Machines • Thread Rolling Machines • Cut Off Machines • Screw Machines • Automatic Lathes • Riveting Machines • Sorting Machines • Four Slide Machines • Zipper Machines and many others

. . . for heavy drilling, milling, boring with unprecedented accuracy be sure to investigate these LAPOINTE MACHINES operated by NUMERICAL CONTROL

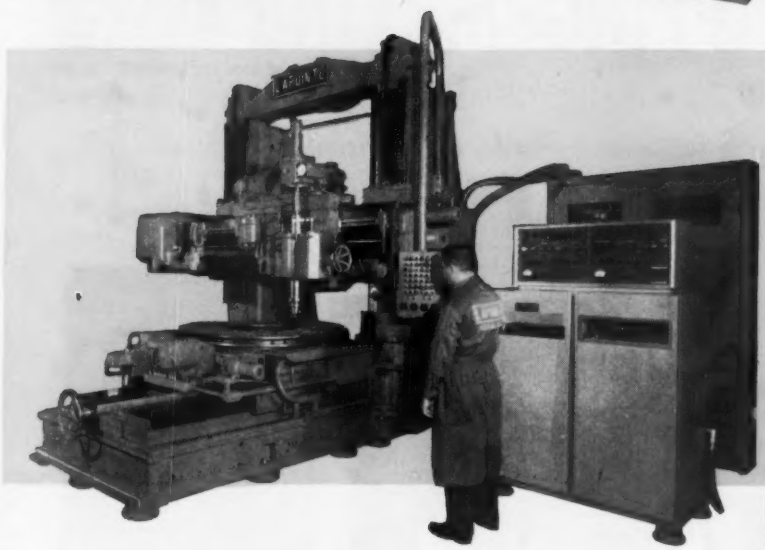


Two new Lapointe-built machine tools are now added to our famous series of broaching machines. Through greater operating accuracy they offer you the opportunity to substantially improve the quality of your products. They bring you important production advantages: saving of set-up time • good for short runs • can use inexperienced operators • eliminate errors and production of scrap parts. Almost human? They're *better* than human.

Plan now to invite a qualified Lapointe Field Engineer to discuss with you the possible application of these numerically controlled Lapointe machines to your operations.

TWO-AXIS
Numerically controlled
LAPOINTE
30/18 AHP AUTOMATIC HOLE POSITIONER with auxiliary drilling head

Ruggedly built to take heavy loads up to 20,000 pounds, not necessarily balanced. Machine can start at full load. Designed for heavy drilling, milling, boring. (Adaptable for broaching.)



TWO-AXIS Numerically controlled
LAPOINTE
48/48 AUHP DRILLING and BORING MACHINE

How the machine can be operated:

A. Tape controlled automatic positioning system.
B. Manual numeric — single cycle operation by dialing in information for each axis.
C. Automatic — through electro-mechanical operation.
D. Semi-automatic — by push button control. In-and-out table provides ease of loading.

Five positioning tolerances are available:

X axis, ± .0005" Z axis, ± .0005"
Y axis, ± .0005" C rotary, 3 seconds of arc of true position
Depth of drill ± .0005"

THE LAPOINTE MACHINE TOOL CO.
HUDSON, MASSACHUSETTS — U. S. A.
In England, Watford, Hertfordshire

THE WORLD'S OLDEST AND LARGEST MANUFACTURERS OF BROACHING MACHINES AND BROACHES

LAPOINTE
known to be the best in
BROACHING

FOSMATIC N/C TURRET DRILL

The drill that carries its own "tool crib". Machine hundreds of different parts without changing tools. Full 3-dimensional tape control including rapid tool selection with the 32-spindle turret. Combined General Electric Mark II and Fosmatic numerical control makes this unique, heavy-duty machine an efficient producer for drilling-tapping-milling with lot sizes as small as one!

NUMERICAL CONTROL *for more effective, lower cost*

DRILLING • TAPPING • MILLING

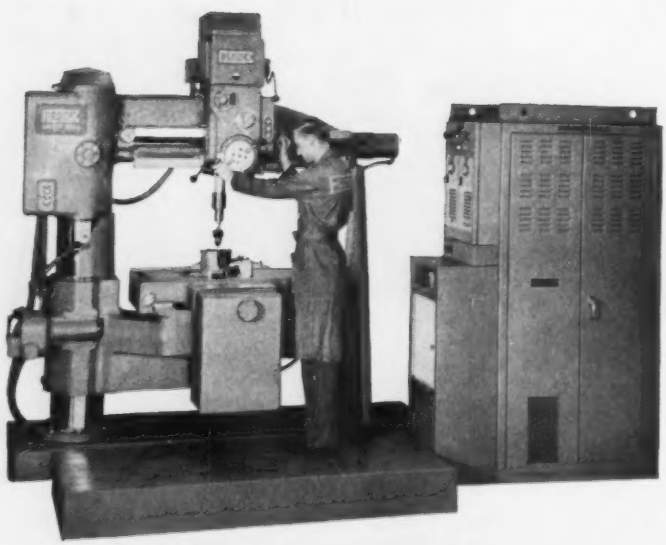
Get a proposal from

FOSDICK

THE FOSDICK MACHINE TOOL CO., CINCINNATI 23, OHIO

FOSDICK N/C LAYOUT DRILL

Keep costs low with this economical machine built to speed drilling and tapping jobs through your shop. Great versatility. Simple in concept, easy to operate. Proven, fast General Electric Mark II numerical positioning control, with full zero offset. The best buy in numerically controlled drills.



NUMERICAL CONTROL FOR PRODUCTIVE PRECISION BORING

FOSMATIC N/C PRECISION BORING MACHINES

Four models from the compact "32" with 18″ x 30″ table travel, to the big "54" with 28″ x 48″ travel. All available with Fosmatic electro-mechanical tape control for table position, spindle depth, head height, speeds, feeds, and tool changing. Fosmatic control positions workpiece accurately to ± .0001″. Fosmatic jig borers make provision for numerical control in the basic design and can be furnished in any degree of automation.

See specifications below.

SPECIFICATIONS: FOSDICK NUMERICALLY CONTROLLED MACHINES

	N/C TURRET DRILL	N/C LAYOUT DRILL	N/C PRECISION BORING MACHINES (Jig Borers)			
			Model 32	*Model* 42	*Model* 44	*Model* 54
Table working surface, in.	18 x 31	24 x 42	18 x 32	18 x 42	44 x 22	54 x 22
Table travel, in.	18 x 24	18 x 32**	18 x 30	20 x 36	22 x 42	28 x 48
Spindle nose to table, in.	3 - 23	3 - 23½	4 - 22½	4 - 28½	6 - 30	6 - 30
Spindle center to column, in.	19½	9 - 43	16½	16½	18½	18½
Head or knee travel, in.	12	16½	9½	15½	15	15
Spindle travel, in.	8	12	9	9	9	9
Spindle speeds, rpm	65 - 2500	75 - 1500*	62 - 3000	62 - 3000	30 - 1800	30 - 1800
Spindle feeds, ipr	.0006 - .012	.004 - .020*	.0005 - .015	.0005 - .015	.0005 - .015	.0005 - .015
Motor hp.	3	3	3	3	3	3
Numerical control	GE Mark II —Fosmatic	GE Mark II	Fosmatic	Fosmatic	Fosmatic	Fosmatic

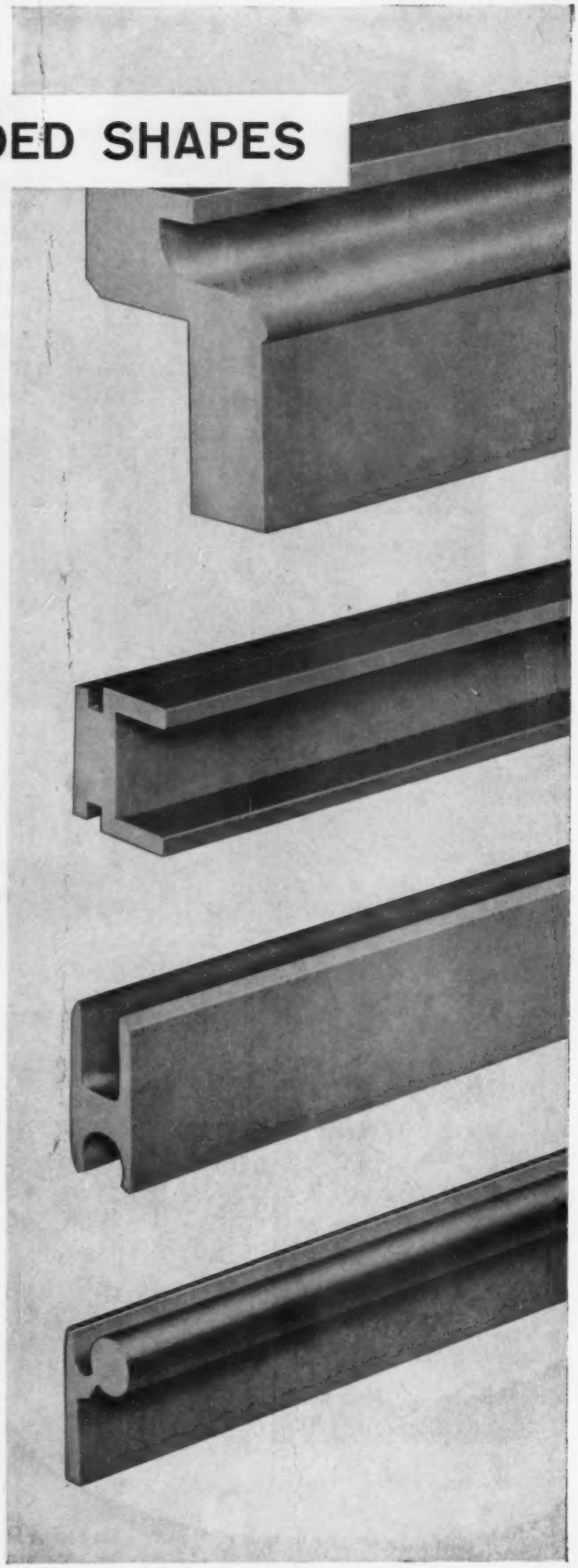
*other ranges available **travel of head on arm

The Fosdick Machine Tool Co., Cincinnati 23, Ohio FOSDICK

ANACONDA EXTRUDED SHAPES

preformed to cut fabricating costs

...preferred for superior quality!



Would you like to reduce machining, scrap, and finishing by *cutting* parts from long lengths of extruded shapes?

Anaconda shows you how . . . by designing long lengths of "pre-machined" shapes exactly suited to the parts you need. Parts made from these extruded brass shapes are characterized by their strong, homogeneous, wrought-metal structure. They are superior, long-wearing parts that *improve* the quality of your finished product. What's more, the smooth, extruded surfaces also reduce many finishing operations —additional savings for you.

Discover why more and more manufacturers are cutting fabricating costs and maintaining better quality by using these preformed shapes. Let our technical service personnel lend practical—and imaginative—help in adapting extruded shapes to the economical production of intricate parts.

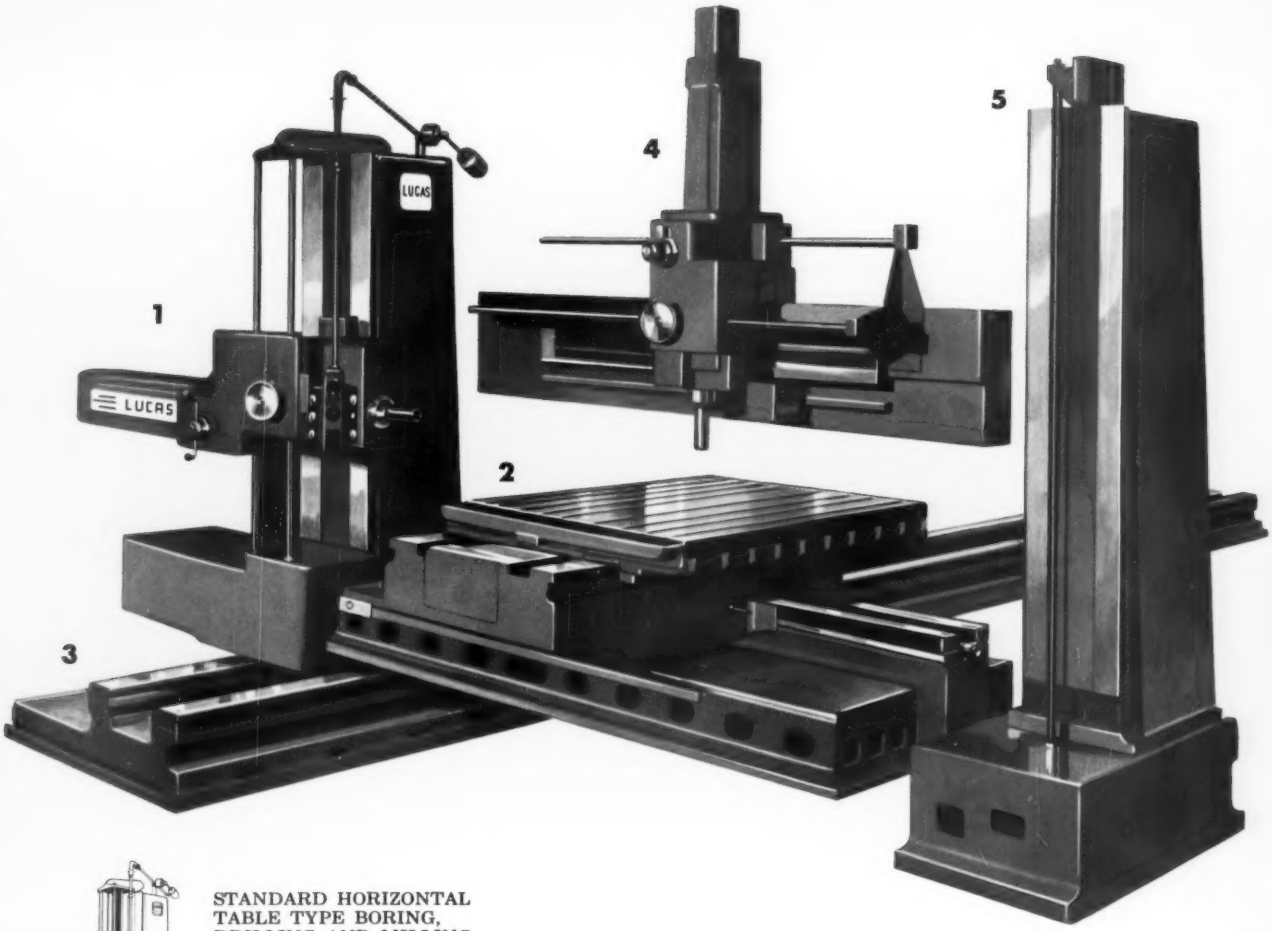
Call your Anaconda representative or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 61-1063

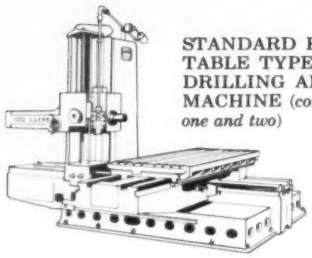
EXTRUDED SHAPES

ANACONDA®
AMERICAN BRASS COMPANY

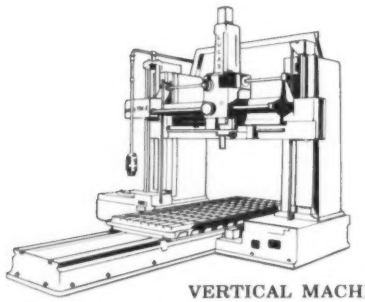
'472

CIRCLE 282 READER SERVICE CARD ►

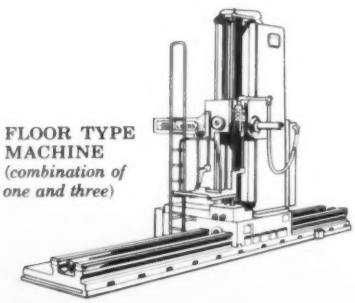




STANDARD HORIZONTAL TABLE TYPE BORING, DRILLING AND MILLING MACHINE *(combination of one and two)*



VERTICAL MACHINE *(combination of one, four and five)*



FLOOR TYPE MACHINE *(combination of one and three)*

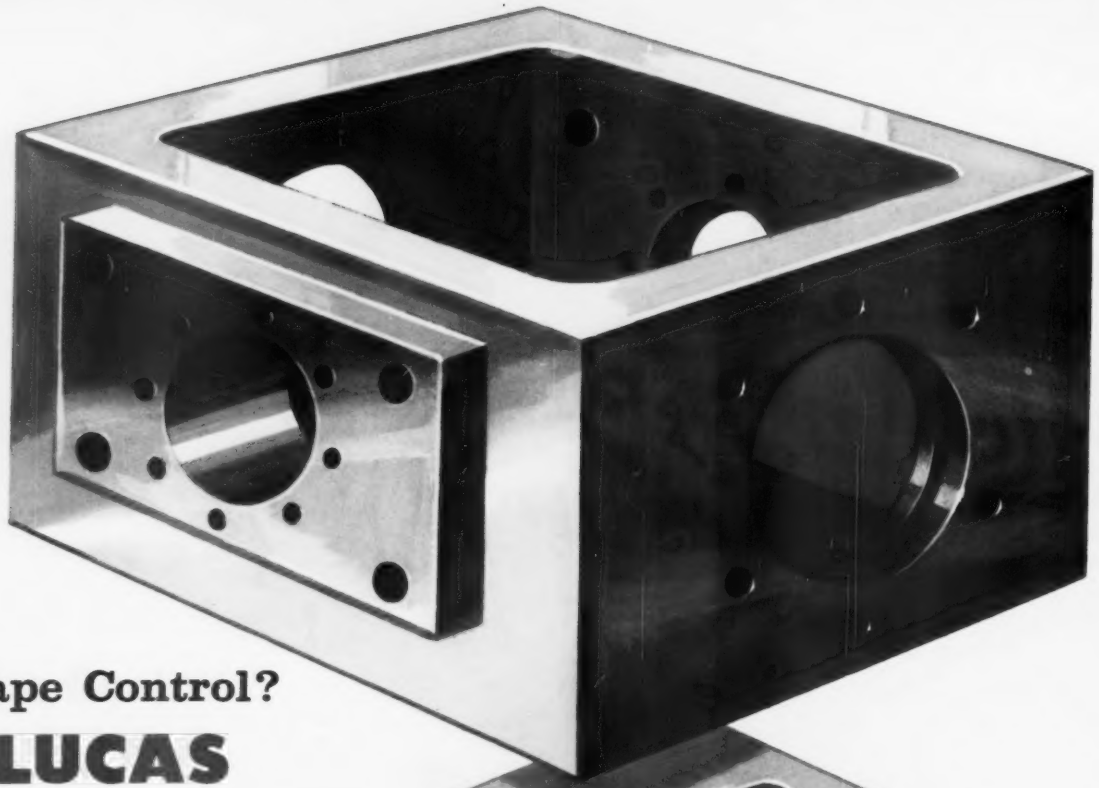
Versatility of Design?

LUCAS

Each Lucas machine—table type, floor type, or vertical—is, in effect, a composite of basic precision-made components, *with integrally cast beds*, assembled to meet your specific requirements. This progressive building-block approach to boring, drilling and milling machine design results in (1) the widest range of field-tested machine models, (2) the same high standards of performance regardless of which type machine you specify, (3) the widest possible range of work with the least number of extra gimmicks and gadgets for so-called "special" jobs. When you want the best that your machine tool dollar can buy, talk to the people who pioneered in the development of the horizontal boring, drilling and milling machine. Lucas Machine Division, The New Britain Machine Company, 12302 Kirby Ave., Cleveland, Ohio.

NOTE: In order to better define the basic components, we have shown main bed castings separated. In actuality, all bed castings are massive integrally cast units providing maximum rigidity for highest precision.

LUCAS
PRECISION

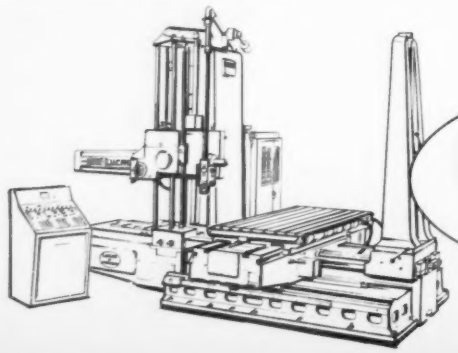


Tape Control?

LUCAS

By offering the widest range of precision table type and floor type boring, drilling and milling equipment . . . by being able to perform the widest range of point-to-point and contouring work . . . by closely coordinating our efforts with the leading producers of numerical controls, Lucas is better able to provide the numerically controlled boring, drilling and milling machines you require.

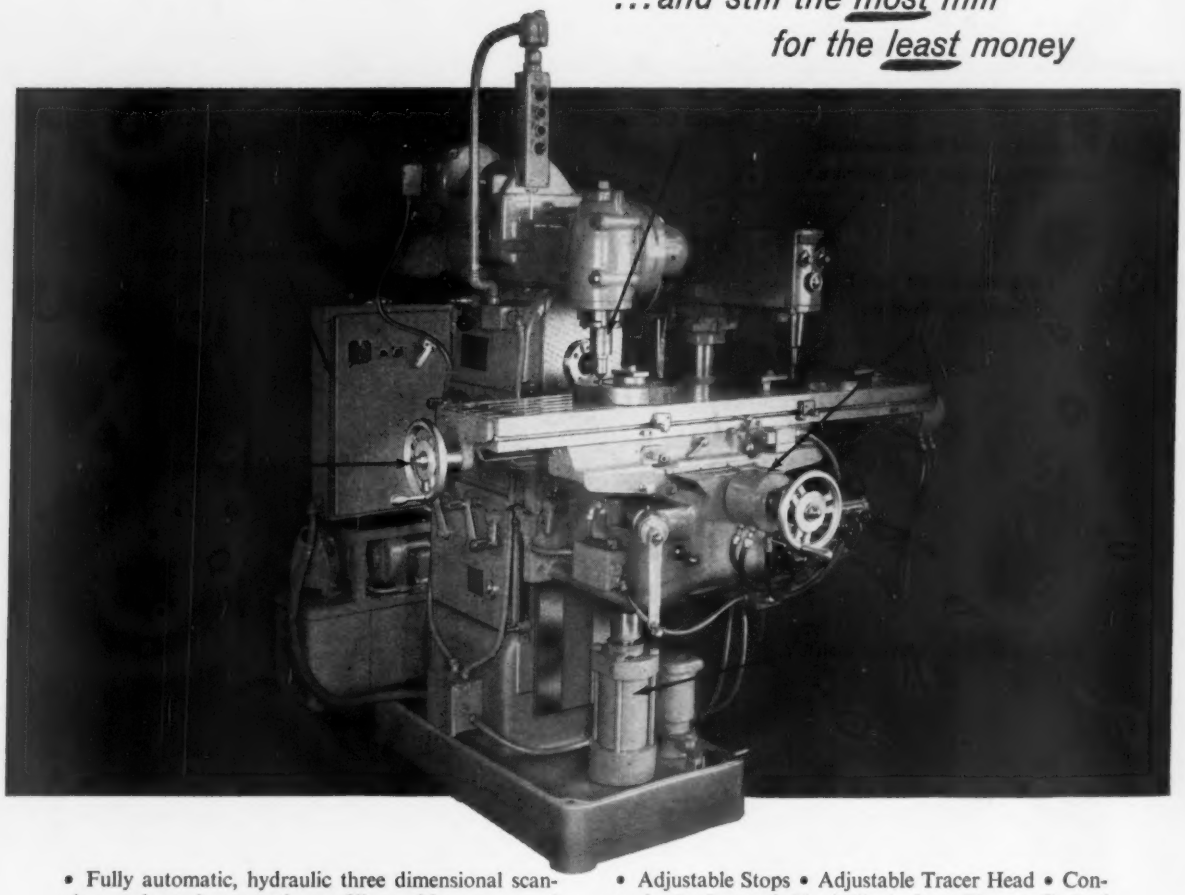
No longer something to read about and think about, good tape controlled equipment is working hard in more and more plants to provide the competitive edge that spells the difference between profit and loss. A numerically controlled Lucas can help you now to cut lead time in the form of direct and indirect labor, reduce inventory, greatly reduce or eliminate jigs and fixtures, eliminate human error, etc. The list is a long one and your Lucas representative is the man who can spell it out book, chapter and verse. Review your requirements with him for a knowledgeable proposal for a numerically controlled Lucas to fit your specific needs. Lucas Machine Division, The New Britain Machine Company, 12302 Kirby Avenue, Cleveland, Ohio.



LUCAS
PRECISION

NOW...GREAVES SCAN-O-MATIC MILLER

...and still the most mill for the least money



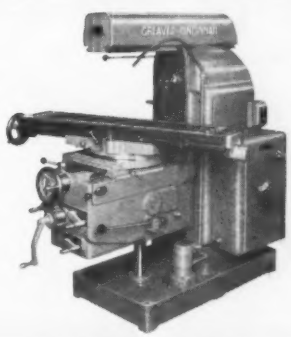
• Fully automatic, hydraulic three dimensional scanning and semi-automatic profiling with power and accuracy for versatile milling! • Automatically follows contour of master straight, angle or curved. • Uniform and accurate cut, since deflection remains constant. • Adjustable Stops • Adjustable Tracer Head • Conveniently Located Feed Control • Tracer Control Selector • Lever Operated Hydraulic Control Panel • Pick Feed Selector • Three dimensional or Conventional Vertical & Horizontal Milling •

The 2H Mill

Rigid cast construction 5 HP—1750 RPM drive motor. Comprehensive speed-feed ranges. Big job capacity.

The 2 XH Mill

More POWER at the cutter. 2 motors—7½ HP spindle drive, separate motor for movable components. Heavy internally ribbed construction.



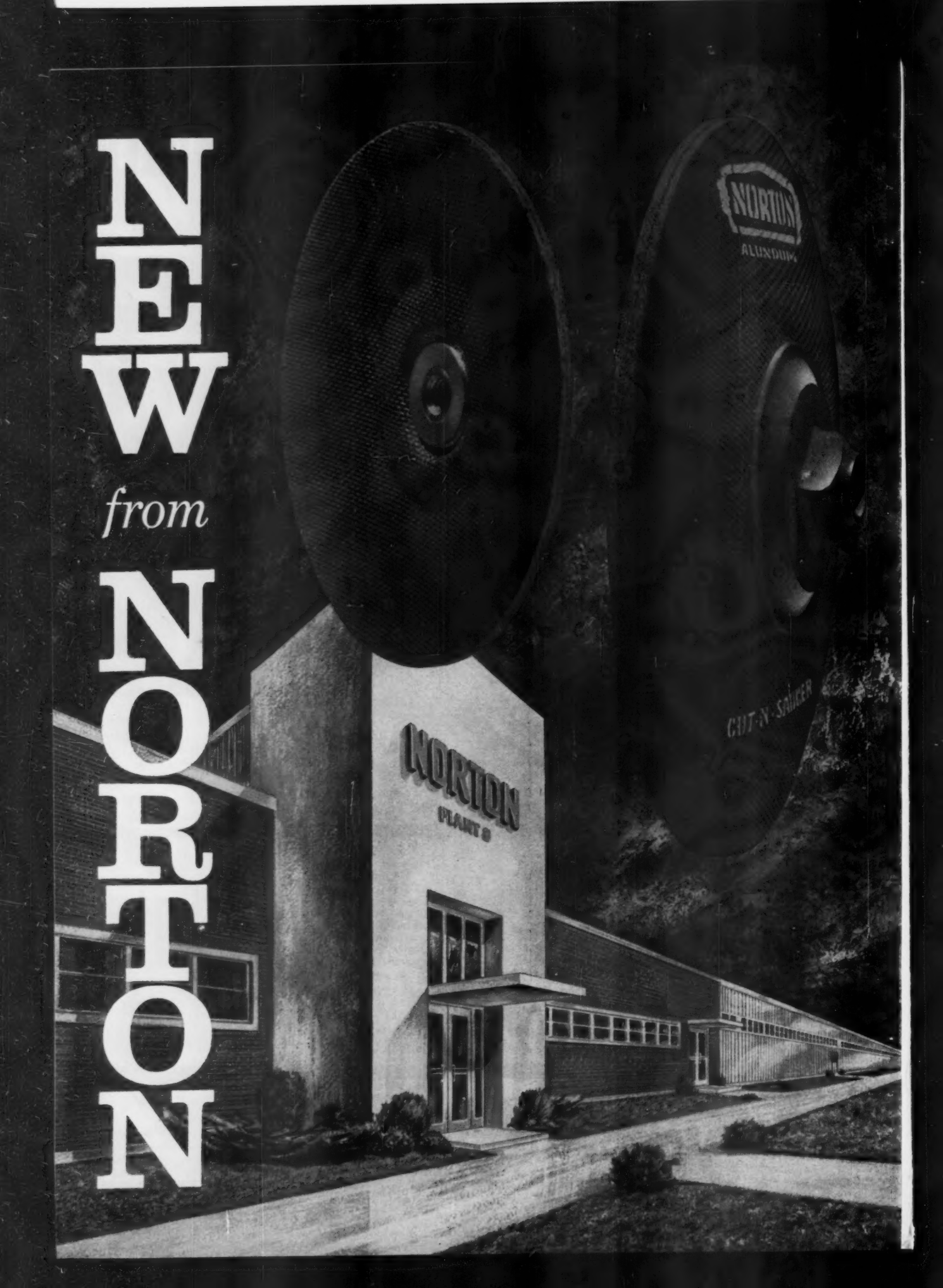
Complete Line of Milling Attachments Available
New Attractive Lease Plan!

GREAVES

GREAVES MACHINE TOOL CO., 100 Eastern Ave., Cincinnati 2, Ohio
Please send me details on Greaves Scan-O-Matic Miller
NAME _____ TITLE _____
FIRM _____
ADDRESS _____
CITY, ZONE & STATE _____

◄ CIRCLE 283 READER SERVICE CARD

CIRCLE 284 READER SERVICE CARD


NEW
from
NORTON
NORTON
ALUNDUM
CUT-N-SMOOTH
NORTON
PLANT 9

CUT-N-SAUCER wheels with DIS-CARD mounts

A new combination from Norton's newest plant

For easier, faster weld-grinding, light snagging and many other portable grinding jobs, Norton now offers you:

The only reinforced wheels that combine a saucer shape with a disposable mount.

These are the new BSA Type Cut-N-Saucer wheels with Dis-Card mounts . . . available in 7″ and 9″ diameters. They are produced in the big new Norton Plant 8, built specifically to improve the manufacture and performance of resinoid wheels.

Reinforced with layers of fibre glass, BSA Cut-N-Saucer wheels gain added advantages from the new shape. Compared with straight wheels, BSA wheels on the job can be held at angles much closer to the horizontal. Results are easier control and reduced operator fatigue.

The Dis-Card mount is equally new and vital. Unlike ordinary mounts it is no separate attachment. It is permanently secured — designed to be bought and thrown away with every wheel. This means you can change wheels in seconds — completely eliminating "lock washer" action and the usual mounting routine that can take up to half an hour. So every Cut-N-Saucer wheel you buy is already mounted — and *stays* mounted, throughout wheel life.

Yet you pay no more for a Norton Cut-N-Saucer than for a conventional reinforced wheel!

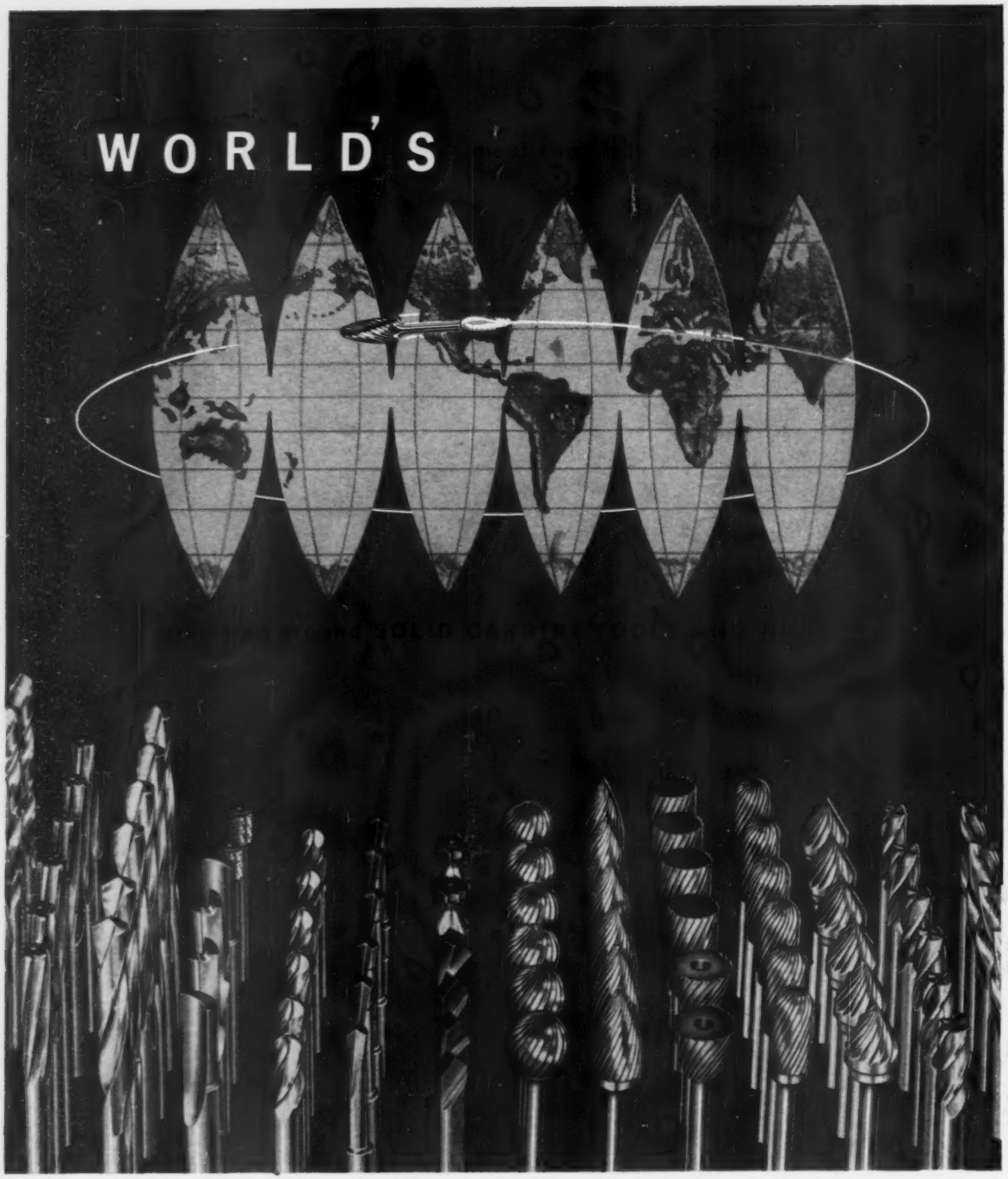
Cash in on this first opportunity ever offered to you to get advantages never before combined in a single, standard priced, portable grinding wheel. For further facts on the new BSA wheels — or on straight wheels also with Dis-Card mounts — see your Norton Distributor, or write to NORTON COMPANY, General Offices, Worcester 6, Mass. Plants and distributors around the world.

NORTON
ABRASIVES

W-2017

Making better products . . . to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Machine Tools • Refractories • Non-Slip Floors — BEHR-MANNING DIVISION: Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes



Atrax

Send for Catalog and Prices

ATRAX SHOP TESTED TOOLS FOR OUTSTANDING PRODUCTION PERFORMANCE

From ¾" diameter solid carbide end mills to miniature 1/64" diameter "Micro" reamers, Atrax precision ground tool uniformity guarantees a production bonus. There is now an Atrax tool or bur engineered and shop tested for any conventional milling, drilling, off-hand grinding or bur operation.

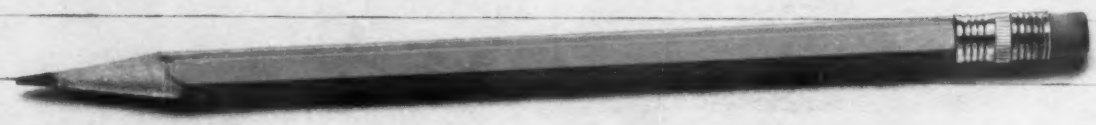
Atrax distributors extend speedy off-the-shelf tooling service throughout the free world!

THE ATRAX COMPANY, NEWINGTON 11, CONNECTICUT, U.S.A.

CIRCLE 287 READER SERVICE CARD

CIRCLE 288 READER SERVICE CARD ►

Lower Your Machining Costs With This Remarkable Tool



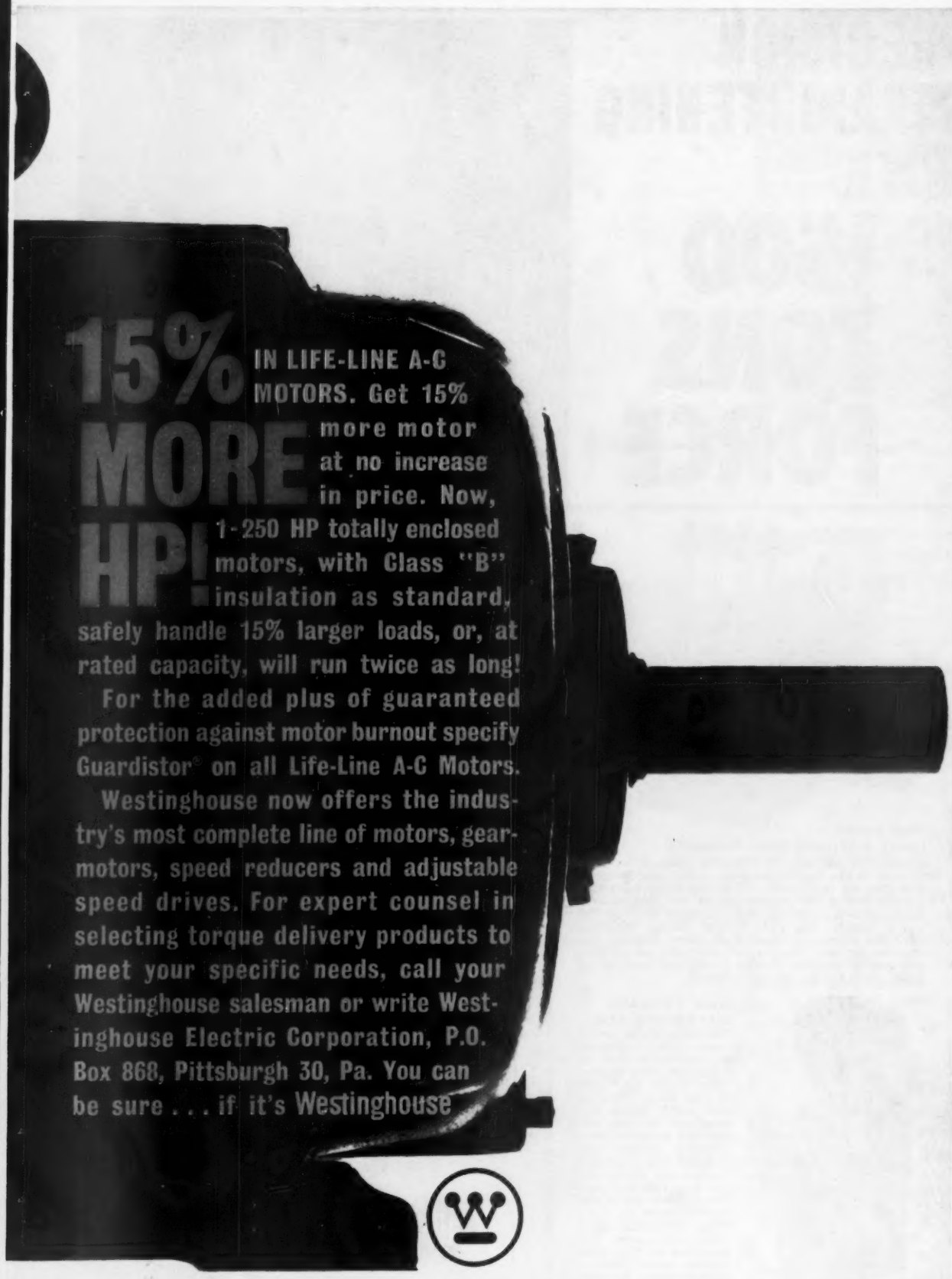
Simply by penciling in a specification for FERROCARBO-treated iron when you order gray-iron castings, you can realize large-scale savings in machining costs. The increased surface machinability of FERROCARBO-treated irons, by independent laboratory test, is 31 to 63 percent. This makes possible savings in the machining of castings that may easily exceed their original cost.

For faster machining, longer tool life and decreased down-time, always specify FERROCARBO-treated castings. They are available from leading foundries everywhere.

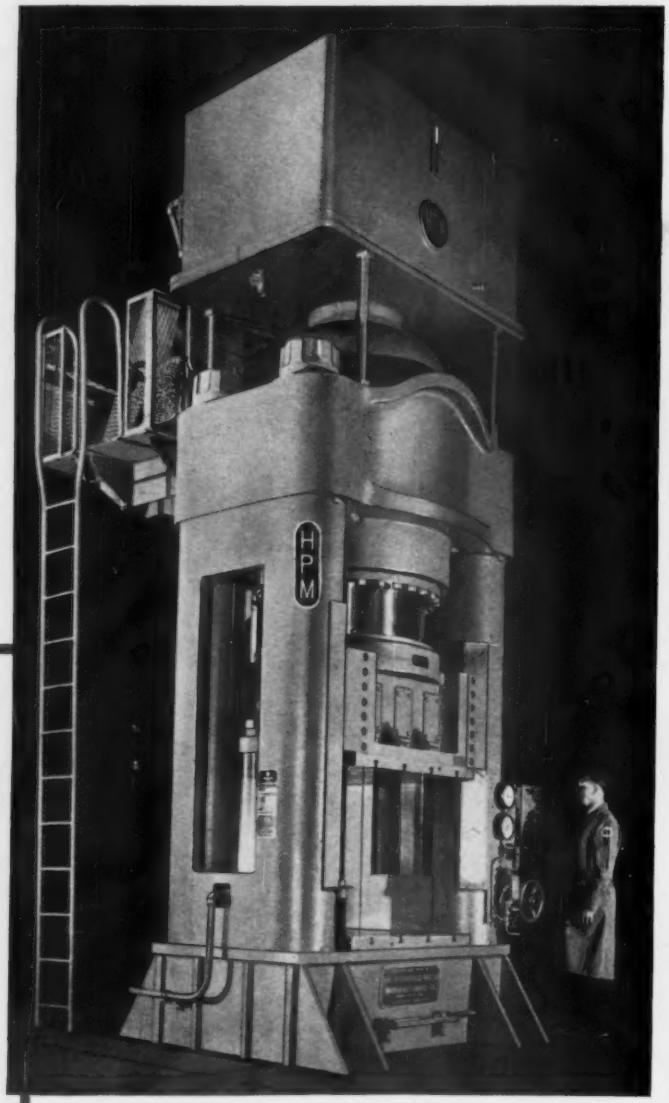
FERROCARBO® is a product by **CARBORUNDUM**

Complete technical data on Ferrocarbo is available to your foundries from Kerchner, Marshall & Company, Pittsburgh, Miller and Company, Chicago.

J-22174

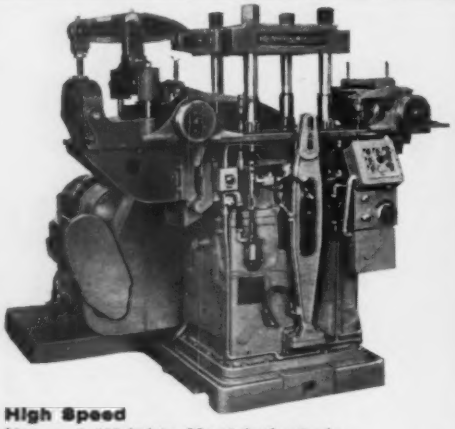

15% MORE HP!
IN LIFE-LINE A-C MOTORS. Get 15% more motor at no increase in price. Now, 1-250 HP totally enclosed motors, with Class "B" insulation as standard, safely handle 15% larger loads, or, at rated capacity, will run twice as long!
For the added plus of guaranteed protection against motor burnout specify Guardistor® on all Life-Line A-C Motors.
Westinghouse now offers the industry's most complete line of motors, gearmotors, speed reducers and adjustable speed drives. For expert counsel in selecting torque delivery products to meet your specific needs, call your Westinghouse salesman or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse

PRECISION STRAIGHTENING WITH 1500 TONS FORCE

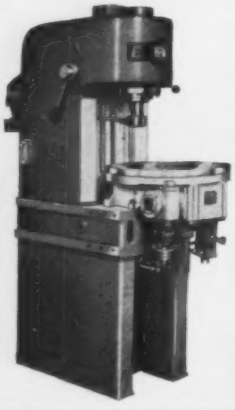


The 1500-ton H-P-M FASTRAVERSE press, illustrated, was especially designed for straightening malleable iron castings. The control system provides means for operating the press either semi-automatic or manually. Change-over from one mode of operation to the other may be made in an instant without stopping the press. A safety control automatically prevents the ram from dropping in the event of power failure or loss of pilot pressure. An emergency reverse push button, if depressed during the forward press travel, will cause the press slide to reverse immediately without completing the cycle. For complete engineering experience and a background in specialized press equipment, contact your nearest H-P-M engineer or H-P-M's home office in Mount Gilead, Ohio.

H-137



High Speed Henry & Wrights Meet Industry's Mass Production Needs The efficient and economical production of complex parts, using progressive dies, are best illustrated by the many successful applications of the popular Henry and Wright line. Available in a range of sizes and types to cover the entire market, Henry & Wright Dieing Machines offer the ultimate in safe, high speed forming and stamping presses. They're fast, accurate, easy on dies and readily adapted to high production work of all types. 25 to 500 ton models available.



Low Tonnage Versatility These compact, high speed bench size C-Presses place either manual or automatic press operations within the range of any shop. They're fast, easily set-up for hundreds of dies, do the work of several less-versatile presses because of ease in changing pressure, stroke and ram speed for each job. The C-Press can be the busiest press in your shop. Automatic index table accessories are available for high production parts loading and processing. Send for complete catalog today.

HPM

H-P-M

DIVISION

Koehring Company

Mt. Gilead, Ohio, U.S.A.

Introducing
CIMTROL CINCINNATI

As the Controls Division of The Cincinnati Milling Machine Co., we have been designing and building components for CINCINNATI machines for many years. Tracer controls. Gage controls. Numerical controls.

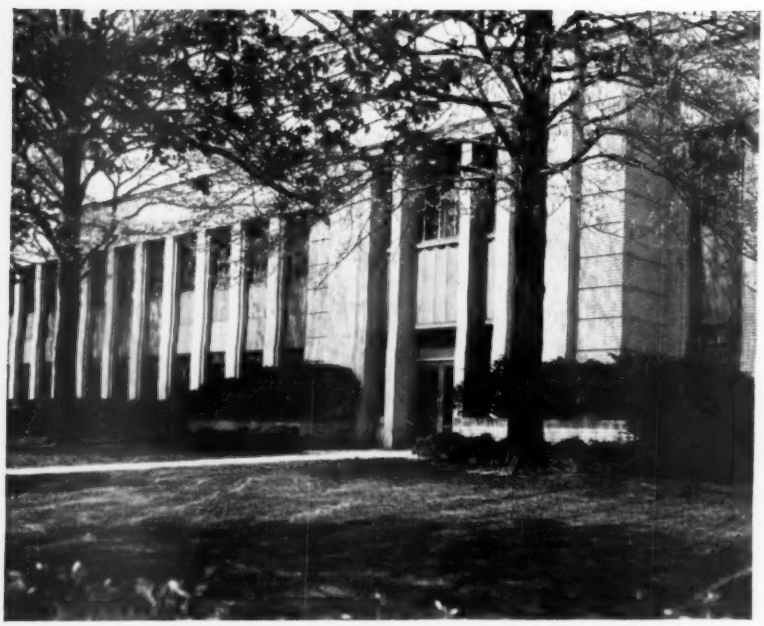
Recently we acquired a new name—CIMTROL.

And now we have a new mission—to offer many of these machine controls to industry at large.

CIMTROL products are described briefly on the next page. In general they are custom designed for specific applications. The exceptions are ACRADRIVE/22 Hydraulic Motors and ACRAFLOW Hydraulic Valves, which you may purchase "off the shelf."

It is our deep conviction that tracing and numerical control systems can rarely be successfully "packaged" and applied in the field. To utilize the full capabilities of a machine, they must be customized, at least to a degree.

We will welcome the opportunity to work with you in developing machine controls to suit your particular requirements. May we hear from you?



Cimtrol Division / The Cincinnati Milling Machine Co.

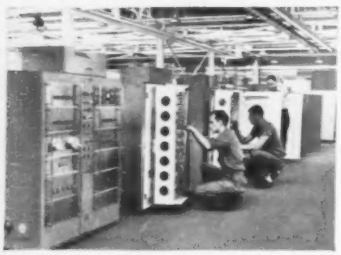
CIMTROL

CINCINNATI

ACRAMATIC

Numerical Control Systems

Positioning—The most complete line of positioning systems—direct or rate controlled, 1 through 5 axes.



Contouring—To suit any practical requirement of range and precision in up to five axes.

Parabolic interpolation for simplified programming because a minimum number of points define any contour.

Absolute measuring. Every point is measured from a single reference—no possibility of cumulative errors inherent in an incremental measuring system.

Cutter size compensation. Use any cutter within ±1″ diameter of the programmed tool. Contouring accuracy is independent of variations in cutter diameter. Rough and finish with the same program.

Other features. Feed rate override. Full-scale zero shift. Electro-hydraulic servo systems. Tape *or* card input. Push-button alignment. Mirror image parts with one program. CIMTROL-developed programming techniques including CINAP computer routines and convenient standarized forms.

CIMTROL

CINCINNATI

ACRADRIVE

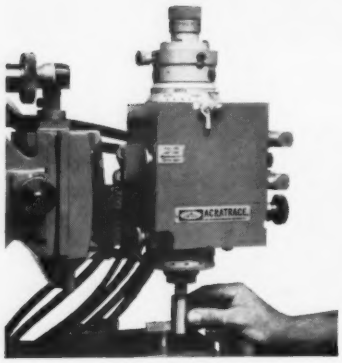
Hydraulic Motors

The ACRADRIVE/22 (shown) is a 22 cu. in. per revolution hydraulic motor capable of delivering precisely controlled power at speeds down to one revolution every 41½ days. It is particularly well suited for direct drives for machine tool axes because of its hydraulic stiffness, high torque-to-inertia ratio, very fast response and wide speed range (max. 500 rpm). Ask for Publication M-2281.

ACRAFLOW

Hydraulic Valves

Electro-hydraulic servo and directional valves; rate, reducing and check valves ideal for ACRADRIVE motors.



ACRATRACE

Custom Tracing Systems

Rate Modified Depth Tracer—the simplicity of single axis tracing plus the ability to negotiate perpendicular surfaces.

3-D Hand Tracer (shown)—also performs as an automatic depth tracer.

And other ACRATRACE control systems, including 2-D and 3-D automatic tracers.

ACRASIZE

Gaging Systems

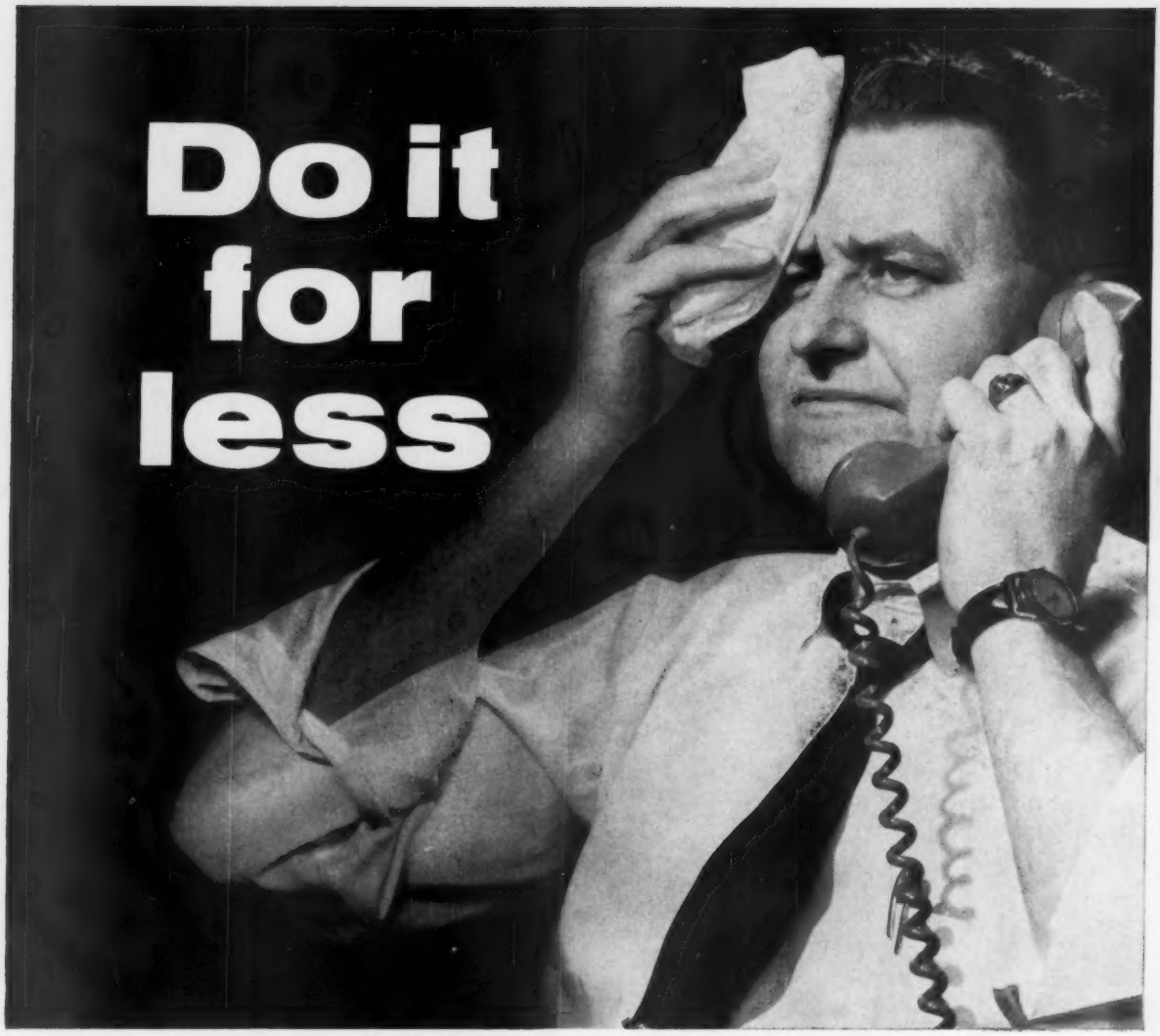
A complete range of gages to control CINCINNATI grinding machines.

CINCINNATI

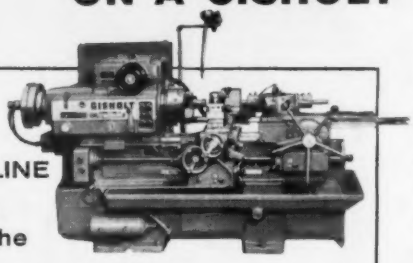
CIMTROL

CINCINNATI

Cimtrol Division / The Cincinnati Milling Machine Company / Cincinnati 9, Ohio



ON A GISHOLT TURRET LATHE



MASTERLINE NO. 4 Ram Type Turret Lathe

Offers fast, easy operation, 16 spindle speeds to 2000 rpm, 25 hp driving motors for maximum metal removal with carbides

Simplified controls, tracers for complex jobs (shown) and operator-oriented design permits handling short-run work at minimum cost in time, labor and tooling.

Contact your Gisholt Representative or write for Catalog 1174-E.

Things can get pretty hot in a job shop. Competition forces you to quote new machine rates. Yet, if you're average, over 60% of the ram type turret lathes in your shop are 10 years old. They're only half as efficient as today's models. It's easy to see how profits . . . and contracts can be lost.

There is only one answer . . . replace old with new. Find out now, how Gisholt Ram Type Turret Lathes can help you do it for less.

GISHOLT
MACHINE COMPANY
Madison 10, Wisconsin, U.S.A.

Turret Lathes • Automatic Lathes • Balancers • Superfinishers • Threading Lathes • Factory-Rebuilt Machines with New-Machine Guarantee

◀ CIRCLE 293 READER SERVICE CARD

CIRCLE 294 READER SERVICE CARD

Operator puts finishing touches on carbide reamer using Bay State Diamond Wheel (specially formulated to hold its shape and require minimum number of dressing operations).

BAY STATE TEAMWORK PAYS OFF AGAIN

with a new diamond wheel for SEVERANCE TOOL

When you use a substantial number of diamond wheels every month, it pays to keep a steely eye on costs. That's why a man like Purchasing Agent Millard Wells of the Severance Tool Industries, Saginaw, Michigan, insists on continuous testing for every cost factor in the book.

The specific problem was to develop an improved diamond wheel for close-tolerance grinding of Severance Carbide Reamers and at the same time to reduce time-consuming, material-wasting dressing operations.

Figuring out the details of the new wheel was a team operation right from the beginning. Bay State's Sales Engineering Staff and the Quality Control people in Westboro worked very closely with Jack Sullivan, of distributor Saginaw Supply Corporation and with Severance's Purchasing Agent Millard Wells.

Result: A specification that increased cutting speed and wheel life with substantially reduced dressing requirements ... and a beautiful demonstration of the benefits that accrue when two companies get together that both insist on quality right down the line.

Your Bay State distributor or direct representative can show you one of the most efficient lines of diamond wheels in the world manufactured with either man-made or natural diamonds . . . as well as offer you the services of a group of specialists whose knowledge of hard-materials grinding techniques is unparalleled. *Better grinding at lower cost . . . that is our business.*

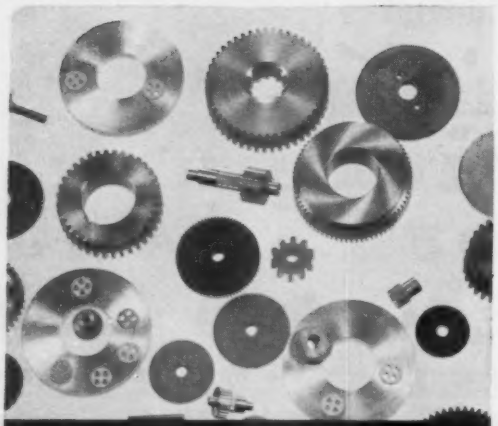
Severance Purchasing Agent Millard Wells (left) and Bay State Distributor's representative Jack Sullivan (of Saginaw Supply Corp., Saginaw, Michigan) examine typical carbide tools which require diamond grinding.

BAY STATE WHEELS of PROGRESS

BAY STATE ABRASIVES

Bay State Abrasive Products Co., Westboro, Massachusetts.
In Canada: Bay State Abrasive Products Co., (Canada) Ltd., Brantford, Ontario.
Branch Offices: Chicago, Cleveland, Detroit, Los Angeles, Pittsburgh.
Distributors: All principal cities.

CIRCLE 296 READER SERVICE CARD

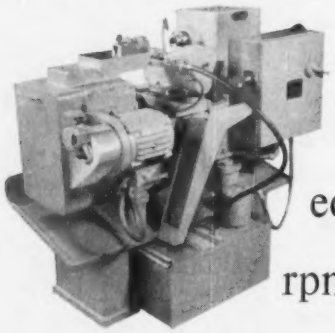


■Here is an opportunity to add powerful sales appeal to your product without increasing costs. As a result of recent Barber-Colman innovations in hobbing, it is economically feasible to put instru-

NEW

ment gear quality into any product. / The new method is production hobbing of fine-pitch spur gears of AGMA Precision Class 3 quality... quality which cannot be produced economically by any other method. It's the new No. 2½-4, a machine which Barber-Colman guarantees will index accurately within 20 seconds of arc. This means that in a 2″ diameter gear, nonadjacent tooth-spacing error caused by machine indexing can be held within

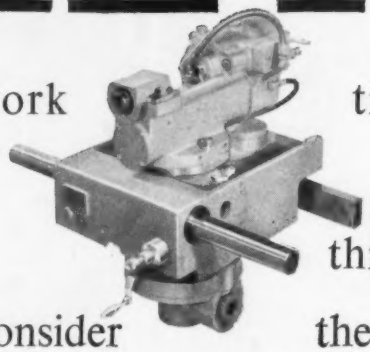
.0001". / This extraordinary precision has been combined with economy through machine simplicity. The position of the work



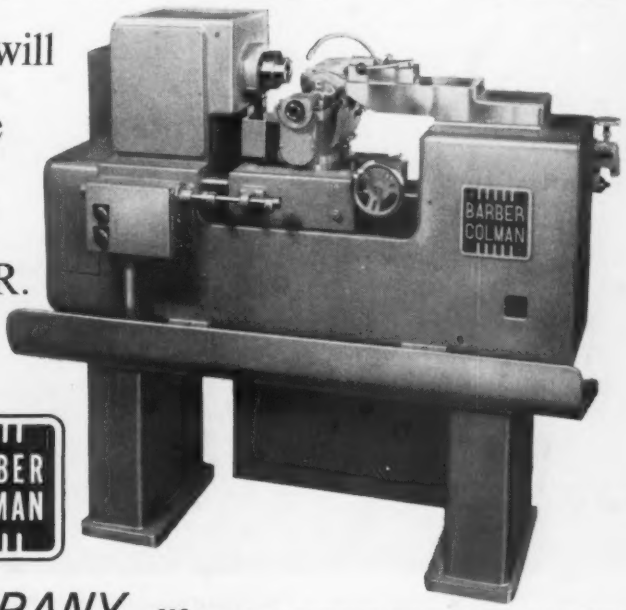
spindle of the No. 2½-4 is fixed, increasing rigidity. Hob carriage is completely antifriction-equipped. Hob speed is infinitely variable to 1200 rpm. A stiff, direct-feed drive eliminates error in

METHOD

hob-to-work

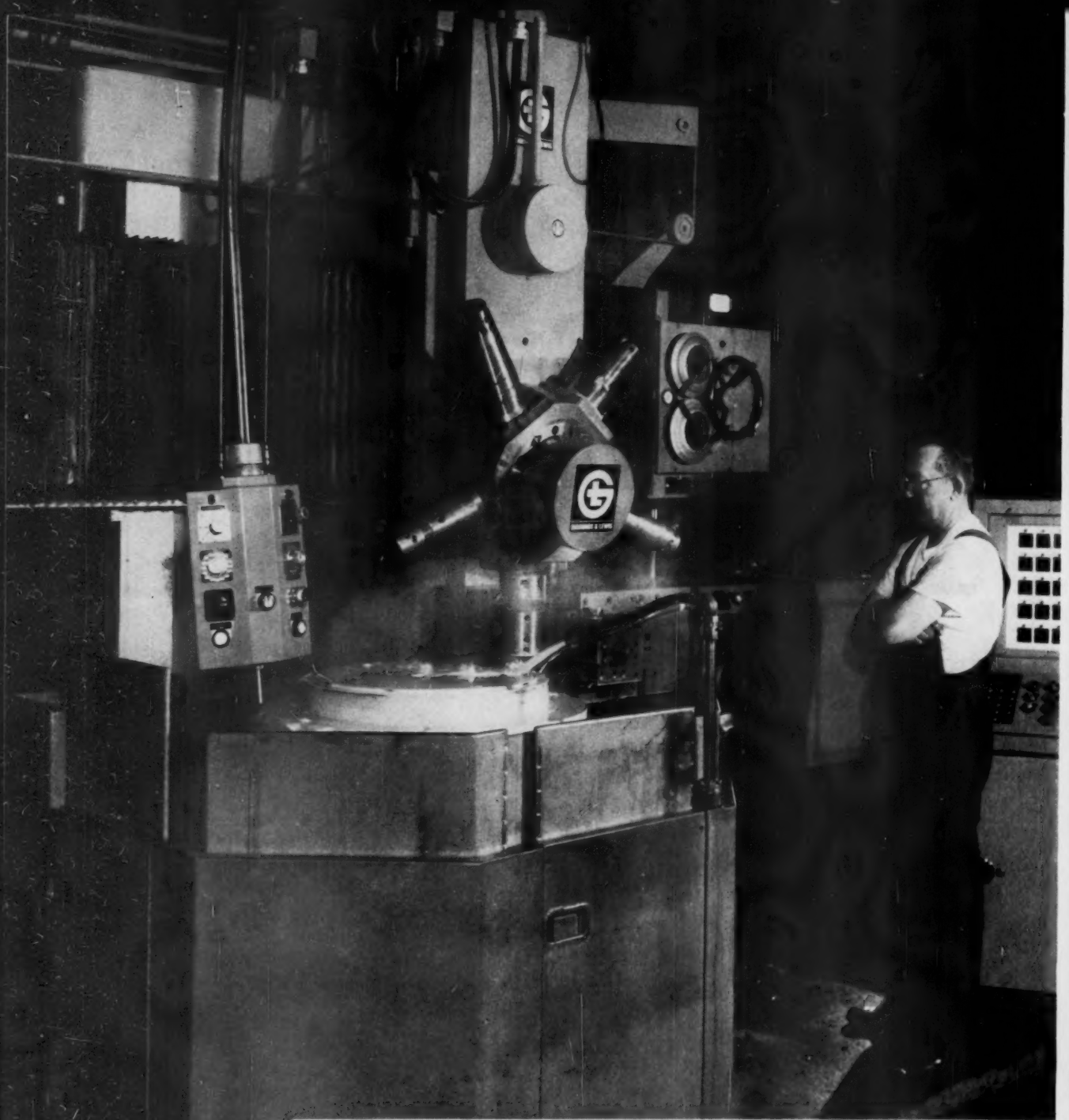


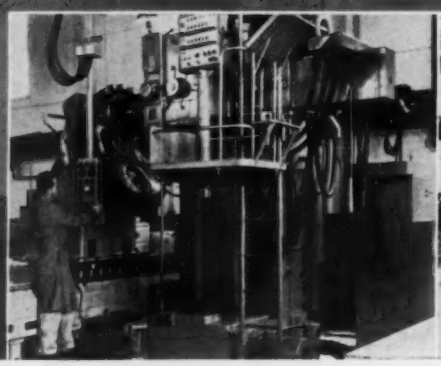
timing. These and other unique machine features are triggering important break-throughs in gear-cutting cost and quality. Consider the total impact of product improvement through precision gearing in your industry—of "cost-free," plus values your customers will recognize and buy. / See the No. 2½-4 hobbing your gear blanks in our TEST CENTER. Your Barber-Colman representative will make all the arrangements.

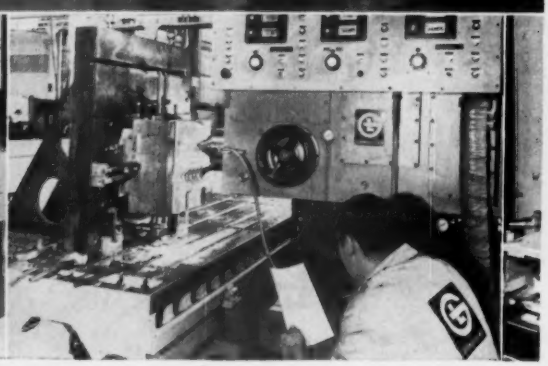


BARBER COLMAN

BARBER-COLMAN COMPANY 912 LOOMIS STREET, ROCKFORD, ILLINOIS





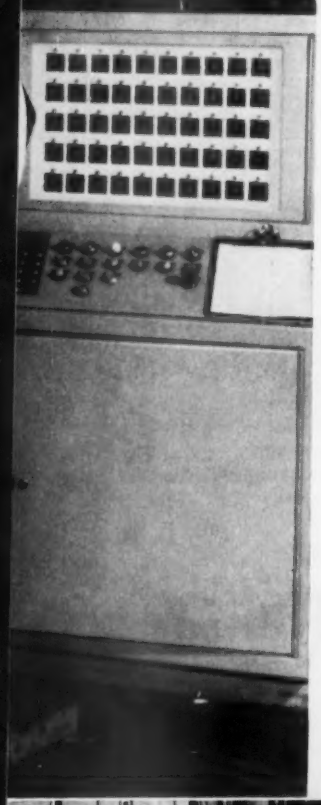


Vertical boring and turning machines — 32" through 20' diameter tables standard — up to 150 hp — positioning or contouring control.

Horizontal boring, drilling and milling machines — table, floor and planer types — 3" to 14" spindles — positioning or contouring control.

Contour milling and die sinking machines — horizontal and vertical — three-axis and five-axis types — up to 30 hp — path control.

CIRCLE 299 READER SERVICE CARD



EVERYTHING

TO HELP YOU INTO TAPE

Tape-controlled machining has "arrived." In almost every shop today, it is no longer a matter of "Should we consider tape control?", but rather, a matter of "How and where should we start?"

You can come with confidence to Giddings & Lewis for the answers to your questions — as well as for the equipment to suit your needs — from simple two-axis positioning tables to five-axis path-controlled contour milling machines.

Giddings & Lewis offers you:

Experience — G&L developed the first commercially available tape-controlled machine tool . . . has produced more major numerically controlled machines than any other builder . . . applies any well recognized control system . . . designs and manufactures numerical control systems.

Machines — A complete new line engineered specifically for the requirements of numerical control.

Economic evaluation — of all the factors affected by tape-controlled machining: floor space, jigs and fixtures, checking and assembly, operator skills, tool life, finish, accuracy, capital investment, machine utilization, product design freedom, length of runs, and other variables.

Test machining of your parts — in G&L shops where all types of G&L tape-controlled machines are used in the company's own production.

Controls — You can have the system of your choice — including controls of G&L design and manufacture, which provide you single-source responsibility for the entire machine "package."

Cutting tools and toolholders — A complete line of Davis presized and quick-change boring tools and VBM and VTL tooling . . . plus arbors, sleeves . . . continuous-feed facing heads . . . tap leaders for machines without thread leads . . . and various other standard and special tools.

Accessories and attachments — Rotary tables with manual or numerical controls, angular milling attachments, angle plates, V-blocks, and other equipment for speeding setups and production.

Fixturing service — Special holding fixtures designed and built to your specific requirements.

Training schools—for programming personnel, operators, and maintenance men for G&L controls.

Reference literature — Programming and control system manuals are provided for reference and training use.

Service backup — by local resident engineers and the factory.

Plan now to "tool up with tape" for maximum manufacturing profit and productivity. For the answers to your tape-control requirements, consult your Giddings & Lewis distributor or the factory. Write for literature.

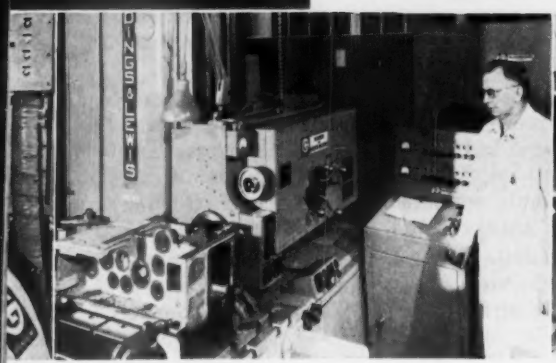
T-61-2

GIDDINGS & LEWIS

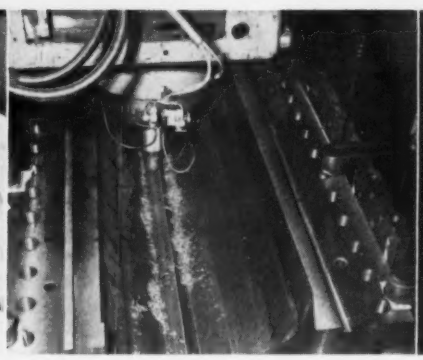
GIDDINGS & LEWIS

GIDDINGS & LEWIS MACHINE TOOL COMPANY, Fond du Lac, Wis.

Jig borers; horizontal boring, drilling, and milling machines; vertical turret lathes; vertical boring mills; positioning tables; die sinking machines; contour milling machines; vertical and horizontal spindle numerical control drilling machines; radial and upright drilling machines; planers; planer mills; numerical and tracer control systems; Davis boring tools.



Jig boring machines with heavy milling capability — horizontal table type with 3" and 4" spindles — positioning control.



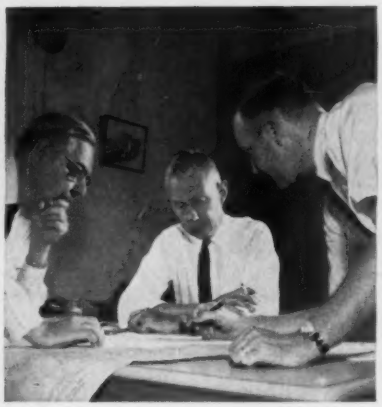
Planer-type milling machines, planer-type contour milling machines — with point-to-point or path control for ferrous and nonferrous machining — head motors to 125 hp.

Horizontal and vertical drilling machines — with two-axis and three-axis point-to-point control (positioning tables available separately).

CIRCLE 300 READER SERVICE CARD

ANOTHER REASON TO SPECIFY **GENERAL ELECTRIC** NUMERICAL CONTROL

FREE FACTORY TRAINING for your personnel helps you maintain adequate preventive maintenance program.



EXPERT APPLICATION HELP is yours from engineers who have applied G-E control to over 50 machine types.

QUICK, EFFICIENT START-UP of machine is certain when field-based General Electric engineer assists.

Complete installation help, training,

When you insist on General Electric numerical control, you do more than assure yourself of profit-making machine-tool performance. Your specification automatically qualifies you for the industry's biggest "extra value" . . . General Electric's complete customer-service package.

General Electric "service" starts the instant your specifications are known. **G-E application engineers**—who work hand-in-hand with **every** major machine-tool builder—help to translate your needs into an integrated, automatic machining system which is completely "checked out" before it comes to you.

Then, **G-E field-based engineers** personally assist in installation, and start-up of your equipment to make sure it performs to specifications. Keeping it

NUMERICAL CONTROL
FOR AUTOMATION

SWIFT, EXPERT SERVICE is yours from General Electric engineers in cities throughout the country.

GENERAL ELECTRIC CONTROL SYSTEM PRE-MATCHED TO YOUR MACHINING JOB is the time and money-saving "payoff" of G.E.'s creative and comprehensive design, application, installation, and service engineering assistance.

maintenance services for every buyer

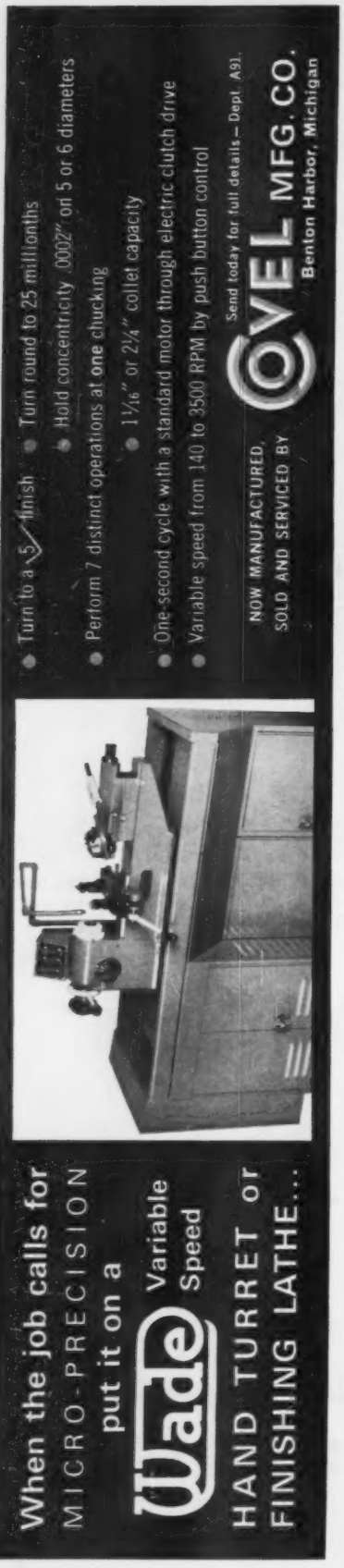
operating at peak efficiency is the job of **G-E service engineers** who are located in 90 principal cities all across the United States.

Another key customer service is General Electric's **factory training school**. To date, more than 1000 customer personnel have learned basic control theory, trouble shooting, and techniques for adjusting and testing G-E numerical control.

Get all the details on these General Electric "extra-value" services . . . a package unmatched by any other control builder. Contact your machine-tool builder or G-E Sales Engineer today. Or write to Section 795–14, General Electric Co., Schenectady, N. Y., for descriptive data. *Specialty Control Dept., Waynesboro, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC


• Turn to a 5 finish • Turn round to 25 millionths
• Hold concentricity .0002" on 5 or 6 diameters
• Perform 7 distinct operations at one chucking
• 1 1/16" or 2 1/4" collet capacity
• One-second cycle with a standard motor through electric clutch drive
• Variable speed from 140 to 3500 RPM by push button control
Send today for full details – Dept. A91.
NOW MANUFACTURED, SOLD AND SERVICED BY
OVEL MFG. CO.
Benton Harbor, Michigan
When the job calls for MICRO-PRECISION put it on a
Wade Variable Speed
HAND TURRET or FINISHING LATHE...

LETTER from the PUBLISHER

Nuts And Bolts

The technological explosion, progressing almost geometrically in recent years, has tended to divert attention from the "nuts and bolts" of manufacturing technology in metalworking. We, ourselves, have dealt in increasing degree with exotic metals, e.g., beryllium, zirconium, titanium, etc. and the problems of working them. We've put increasing emphasis on such techniques as chemical milling, electrical discharge machining, electro-jet drilling with tolerances to 40 millionths, ceramic tooling, automation and numerical cont[illegible].

All are important . . .

No one could argue for a moment that the foregoing are not important. They are. Vitally! For it is in this area that a technical publication leads; justifies itself by reporting first on new developments; helps you as a manufacturing man by pointing the way to cost saving, more profitable production.

Yet essentially these developments are "blue sky." They are new, it is true. They represent pioneering. They are methods you *must* know about. They are techniques you *will* adopt; and probably sooner than you think. But what about the run-of-the mill practices in metalworking shops. Can any publication afford to ignore them?

Certainly not . . .

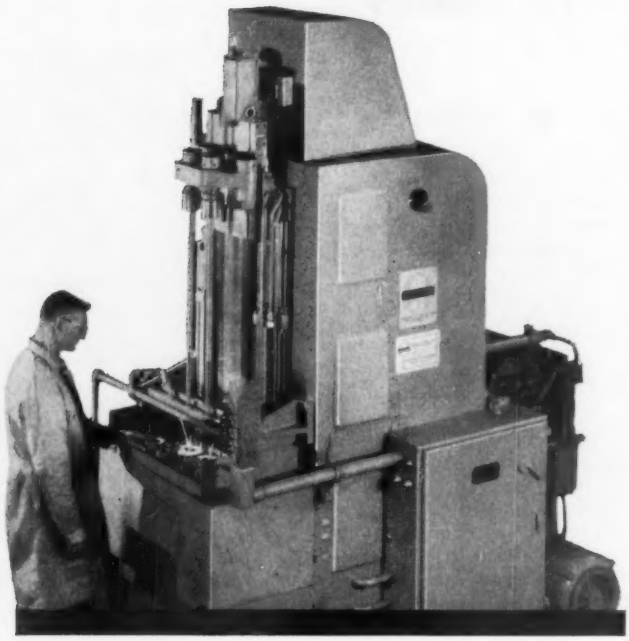
We cannot. You will find in every issue of AMERICAN MACHINIST/METALWORKING MANUFACTURING a hard core of editorial material on fundamental manufacturing techniques and procedures, a nucleus of basic shop practice. Even in this issue, unusual in that the bulk of its editorial content is devoted to the profit potential of numerical control, you will find "Practical Ideas," "Talking Shop," "New Materials," and "Reference Book Sheets"—the kind of gutsy material that truly contributes to your day-to-day shop operation.

We plan to keep it that way. This is the "nuts and bolts" of metalworking manufacturing and, I might add, can be the highly profitable part for you.

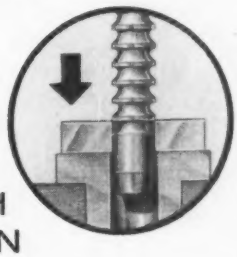
George Reppert

CONVERTIBLE

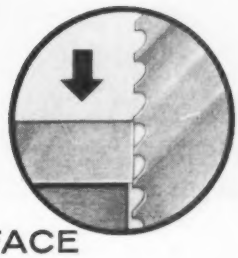
SUNDSTRAND-AMERICAN VERTICAL BROACHING MACHINES



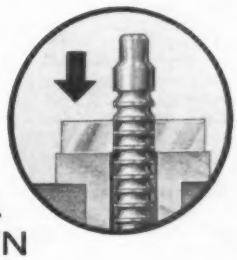
Unit construction simplifies change-over to these operations



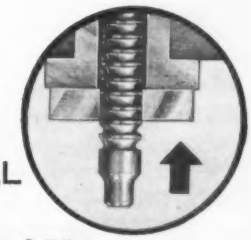
PUSH DOWN



SURFACE



PULL DOWN



PULL UP

At moderate cost — in a matter of hours — you can convert a basic Sundstrand-American vertical broaching machine to any of the arrangements illustrated.

Thus you can meet a variety of requirements with a single machine and changeover assemblies, or you can buy a machine for one type of operation today, confident that it will not be obsoleted if your requirements change tomorrow.

These new 4-way convertible broaching machines are built in both single and dual ram models. Capacities are 5, 10, 15, 25, 40, and 50 ton, with strokes from 30″ to 90″, depending on tonnage — 22 stroke tonnage combinations in all. All operations are from a pushbutton station.

Sundstrand backs these machines with an "Engineered Production" service which evaluates your requirements and offers all three elements essential to peak broaching performance:

1. *Correct broach tool design* — This logical first step in solving a broaching problem requires consideration of stock removal, length and width of cut, finish, tolerances, etc., so broach fixture and machine operate as a team.
2. *Specifying the right machine* — Production rate required, length and speed of stroke, floor space, and relationship with other production machinery are all considered before recommending the machine for a job.
3. *Efficient fixturing* — This vital third link in the production chain enables production schedules to be met even with inexperienced operators because fixtures are provided with the skills "built in."

For complete information, write today.

Ask for new Bulletin 633, describing in detail the basic machine units and conversion assemblies, machine design features, and optional accessories. Detailed dimensional data and specifications are given for all models. Write for your copy today.

SUNDSTRAND

SUNDSTRAND-AMERICAN BROACHING EQUIPMENT

SUNDSTRAND MACHINE TOOL

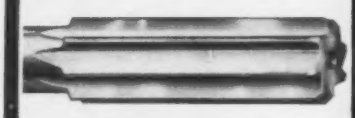
DIVISION OF SUNDSTRAND CORPORATION

BELVIDERE, ILLINOIS

holes we had nothing to do with

L&I reamers are **not** used in donut making. But almost any place else in the metalworking field, chances are you'll find L&I reamers used for precision finishing and sizing of holes. L&I offers you **the most complete line of reamers** including miniature sizes, wire gage sizes, letter sizes, dowel pin reamers, fractional reamers by 64ths, all in both straight and spiral flutes. This means lower first cost . . . greater efficiency . . . increased production . . . and more savings per reamed hole.

FREE! A POCKET CHART OF DECIMAL REAMERS. See your L&I distributor or write today.



L&I

LAVALLEE & IDE, INC.

"THE REAMER SPECIALISTS"

CHICOPEE, MASSACHUSETTS

LETTERS

to the editors

330 W 42nd St, New York 36, NY

Free Indexes

Dear Sirs:

In preparing our periodicals for the bindery. we find that we have not received an index to AMERICAN MACHINIST/METALWORKING MANUFACTURING for 1960.

We should like to know if you publish an index for each year. If so, cou'd you supply us with one.

Helen Puckett
Chief Technical Librarian
Avco Corp
Cincinnati, Ohio

Indexes are published each February for the previous year. They are available to subscribers without charge upon request to our Reader Service Department—Ed.

Book Review

Dear Sirs:

In a recent issue (*AM/MM*—Aug 7 '61, p158) I was surprised and very pleased to discover the review you had written of my recent book. It was most generous both in tone and in space, and I certainly appreciate the time and effort you took to do such a thorough job.

Powell Niland
Professor of Management
Washington University

St Louis, Mo

Professor Niland's book is Management Problems in the Acquisition of Special Automatic Equipment, *described by the reviewer as "must reading for any company about to embark on its first experience with special automatic equipment." Publisher is Harvard University—Ed.*

Quick-Setting Epoxy

Dear Sirs:

We noted with interest the article "Templet Is Molded Epoxy" in a recent issue (*AM/MM*—May 29 '61, p87). We were especially interested in the author's remark: "The only possib'e factor that could be a deterrent would be the waiting time needed for the epoxy to set."

Actually, there are other deter-

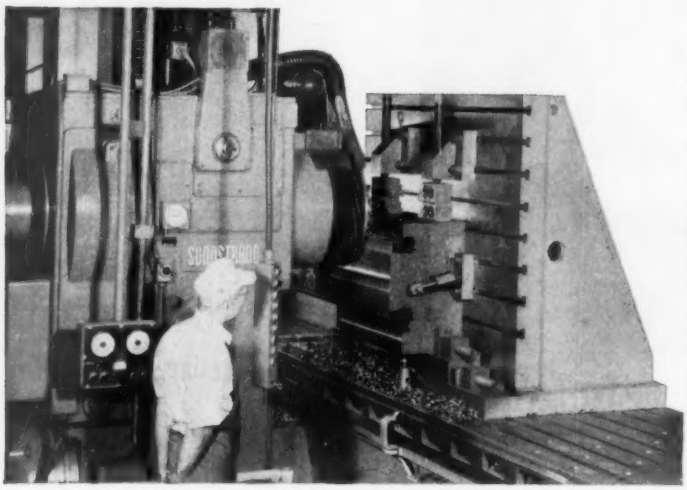
SHOPMATES

N. Jarvis

MY KID BROUGHT MY LUNCH IN AND NOW I CAN'T FIND HIM ....
HE'S IN THE OFFICE .... TALKIN' TO THE WHIP!
.... AND MY DADDY TOLD MY MOMMY YOU WON'T GIVE HIM A RAISE 'CAUSE YOU'RE A OL' TIGHT WAD .... AN' HE HAS TO DO MOST OF YOUR WORK 'CAUSE YOU'RE SO DUMB .... DADDY SAYS YOU SLEEP ALL DAY .... WHEN YOU AREN'T HOLLERIN' AT THE HELP .... ETC .... ETC .... BLA .... BLA .... BLA
AND .... WHAT .... IS .... DADDY'S NAME .... LITTLE .... BOY ??
SNAP
KRAK
N. JARVIS

RIGIDMIL

RIGIDITY...THE KEY TO SUCCESSFUL MILLING



It's easy to put horsepower into a milling machine, but can you deliver this horsepower to the tool without chatter, vibration, or accuracy-destroying deflection? The answer is "yes", with a Sundstrand Rigidmil.

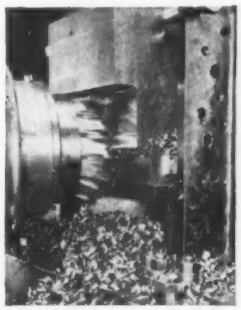
Sundstrand has a reputation for building extremely rigid precision machines — a reputation that is fulfilled to the maximum in its complete line of Rigidmils.

You can use the full horsepower that's built into the machine without any sacrifice in smoothness and accuracy of operation. You can take heavier cuts, run at higher speeds, and use larger diameter cutters. The result is greater production . . . plus longer tool life . . . plus greater accuracy . . . plus better finishes than would be possible with less rigid machines.

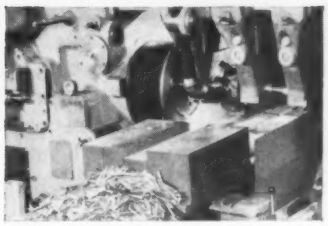
When you buy a Sundstrand Rigidmil, you get *more machine* — with the weight where it counts to set completely new standards of milling performance in your plant.

Ask for a Sundstrand "Engineered Production" analysis which evaluates your requirements from the standpoint of production, range and size of parts, types of milling operations, and the economics of the machine and the machining. Based on this study, Sundstrand engineers will recommend the machine that's best for the job — and best means most economical in the long run. Ask for complete information.

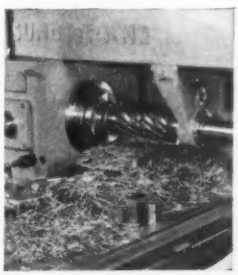
SUNDSTRAND RIGIDMIL RIGIDITY MAKES POSSIBLE CUTS LIKE THESE



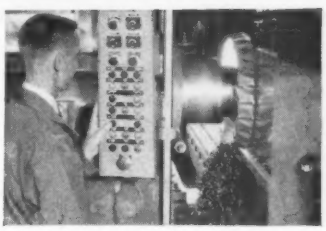
Ruff milling shank in steel die block. Cut is .400" deep by 5-1/2" wide taken with 10" dia. carbide cutter.



This cut in mild steel is 1-1/2" deep by 4" wide, taken with an HSS 8-1/2" dia. channeling cutter.



This slab milling cut on a steel forging is made with two 6" dia. x 6" wide helical HSS cutters. The cut is 1/8" deep by 12" wide.



In this face milling cut on die block steel a 14" dia. carbide face mill is shown in a cut 3/8" deep by 10" wide.

SUNDSTRAND

SUNDSTRAND MACHINE TOOL

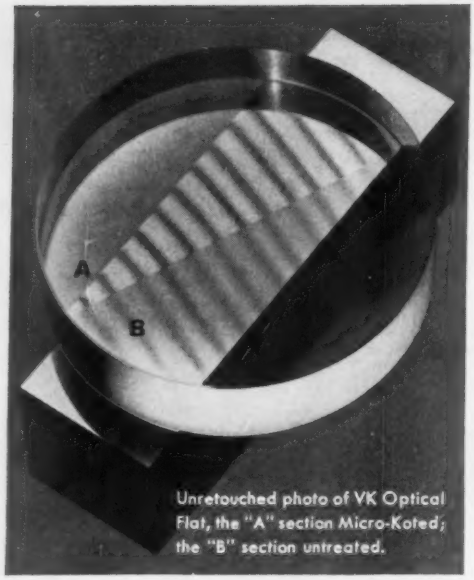
Division of SUNDSTRAND CORPORATION

BELVIDERE, ILLINOIS

You'll see why Sundstrand Rigidmils do more work more accurately day after day when you study their design features in Bulletin No. 629-1. Ask for your copy today.

VK

Checking surface flatness **down to 1/10 of a band?** (.000001-inch) You can do it easily with the



Unretouched photo of VK Optical Flat, the "A" section Micro-Koted; the "B" section untreated.

VAN KEUREN MICRO-KOTED* OPTICAL FLAT

Elimination of the fuzzy edges of the interference bands gives you *greater precision* and *readability*... and faster checking, too, because you get the pattern quicker. There's stronger contrast, a brighter field. The narrow band, very black and sharp-edged, has a width corresponding to a height difference of about .000001".

Having several times the effectiveness of ordinary flats, you might think that VK Micro-Koted Optical Flats are expensive — but that's where you'd be wrong. They cost only 10% to 15% more than uncoated flats. They do not require special handling; they have amazingly long life. One user checked more than 10,000 pieces of permanent magnetic material (carbon seals and Alnico seals) without any appreciable wear. Speaking of VK Micro-Koted Flats, one man said, "It makes a hell of a difference! We wouldn't buy a flat *unless* it was Micro-Koted!" That's the kind of compliment that makes us do our best!

Originated by Van Keuren in 1957, these Micro-Koted flats are perfect for checking bronze, brass and other metals used for magnetic seals, and for checking other critical parts, for surface flatness.

Write today for descriptive leaflet, "Micro-Koted Flats".

* VK Micro-Koted Optical Flats are treated on one side with a transparent layer of hard metal.

NEW! VK Handbook #36 Sect. II (Revised) ENGINEERING DATA is now available at $2.00 per copy.

THE **VAN KEUREN** CO.
173 Waltham Street, Watertown 72, Mass.
PRECISION MEASURING TOOLS . . . rated the world's most accurate
Plug and Ring Gages • Plain and Thread Gages • Gage Blocks
Optical Flats and Light Wave Equipment • Precision Lapping Service and Parts • Measuring Wires
WA 6-1450

rents in the use of epoxy for this purpose: the time required for mixing in initial preparation; the lack of salvageability; and limited pot life and shelf life.

Cerrotru, the product we would select for this application, overcomes these disadvantages, however. There is no time lost in weighing and stirring ingredients; the user simply takes the required quantity of Cerrotru and melts it. Once the alloy is applied, it freezes within seconds or minutes. Unlike most plastics, the alloy can be used again and again. And, being metal, it has an unlimited pot life and shelf life.

O J Seeds
Cerro Sales Corp
Subs of Cerro Corp
New York, NY

Traveling Keyboard

Dear Sirs:
Your August 21 issue mentions (on page 3) a keyboard that directs conveyor operations while traveling on the conveyor. Where can I get more information?

S Jacoby
Los Angeles, Calif

Dear Sirs:
In your August 21 issue, you state that the mechanical keyboard called Select-O-Matic can be adapted to already-installed conveyor lines. It's a little difficult to see how this can be done. Would you please give the maker's address, so that I can write him directly?

S J Freeman
Chicago, Ill

Write directly to the maker: Select-O-Matic Div of Telesonic Packaging Corp, 208 W 27th St, New York City—Ed.

AM/MM

"Are you sure you're working from the right blue prints? ! !"

CALENDAR

Industrial Management Society— Industrial Engineering and Management Clinic, Nov 1-2, Pick-Congress Hotel, Chicago, Ill.

National Electrical Manufacturers Association — Annual Meeting, Nov 16, Plaza Hotel, New York.

American Society of Mechanical Engineers — Winter Annual Meeting, Nov 26-Dec 1, Statler Hilton Hotel, New York, NY.

Society of Automotive Engineers —Annual Meeting and Display, Jan 8-12, Cobo Hall and Convention Arena, Detroit, Mich.

Joint National Symposium on Reliability and Quality Control, Jan 9-11, Statler Hilton Hotel, Washington, DC.

Society of Plastics Engineers — Annual Technical Conference, Jan 30-Feb 2, Penn-Sheraton Hotel, Pittsburgh, Pa.

Material Handling Institute — Spring Meeting, Feb 6-8, Hilton Inn, Atlanta, Ga.

American Society for Metals — Golden Gate Metals Conference, Feb 15-17, Fairmont Hotel, San Francisco, Calif.

Society of Automotive Engineers —National Automobile and Production Meeting, Mar 12-16, The Sheraton Cadillac, Detroit, Mich.

Pressed Metal Institute — Spring Technical Meeting, Mar 14-16, Commodore Perry Hotel, Toledo, Ohio.

Society of Automotive Engineers —National Aeronautic Meeting and Display, Apr 3-6, Hotel Commodore, New York, NY.

American Foundrymen's Society —Castings Congress and Exposition, May 7-11, Cobo Hall, Detroit, Mich.

American Institute of Industrial Engineers — National Conference, May 17-19, Ambassador Hotel, Atlantic City, NJ.

Society of Automotive Engineers —Summer Meeting, June 10-15, Chalfonte-Haddon Hall, Atlantic City, NJ.

DO YOUR PLANS INCLUDE MORE INCOME PRODUCING EQUIPMENT?

"Talk to Talcott First"...

ABOUT LEASING, the arrangement that gives you full use of production and commercial equipment you want, without the burden of large capital investment and risks of obsolescence. A Talcott Leasing Plan lets you choose and use the desired equipment without depleting your working capital. If you can use new equipment profitably, it will pay you to "Talk to Talcott."

For Leasing brochure, write to Robert N. Tuttle, Vice President, Talcott Leasing Corp., 229 Park Avenue South, New York 3, New York. Dept. 10.

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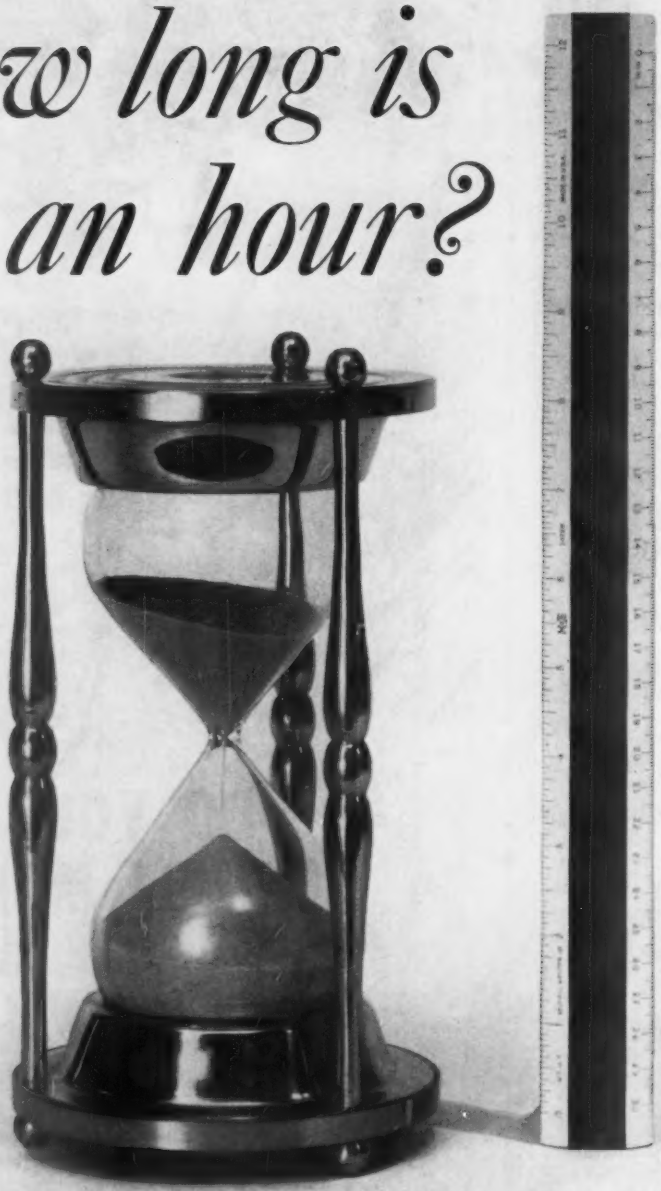
SAN FRANCISCO • MIAMI • PUERTO RICO • MONTREAL (ITL)

How long is an hour?



600 miles long. In this jet age the United States is only "six hours" wide. Emery Air Freight now makes all business "local" by reducing the "distance," measured in "time," between buyer and seller. Precious time saved on important deliveries by Emery—a day or even an hour—is time earned for efficient use elsewhere. Emery provides a complete, flexible, fully-expedited service that includes reserved space on *all* major airlines, giving your order the guarantee and priority of a passenger reservation. And Emery's cross-country network of private wire communications maintains a constant "watch" on all your shipments. Your Emery representative is an air freight specialist. He can show you how to get every penny's worth of value from your shipping dollar. The savings may well surprise you. Call him today or write . . .

EMERY AIR FREIGHT

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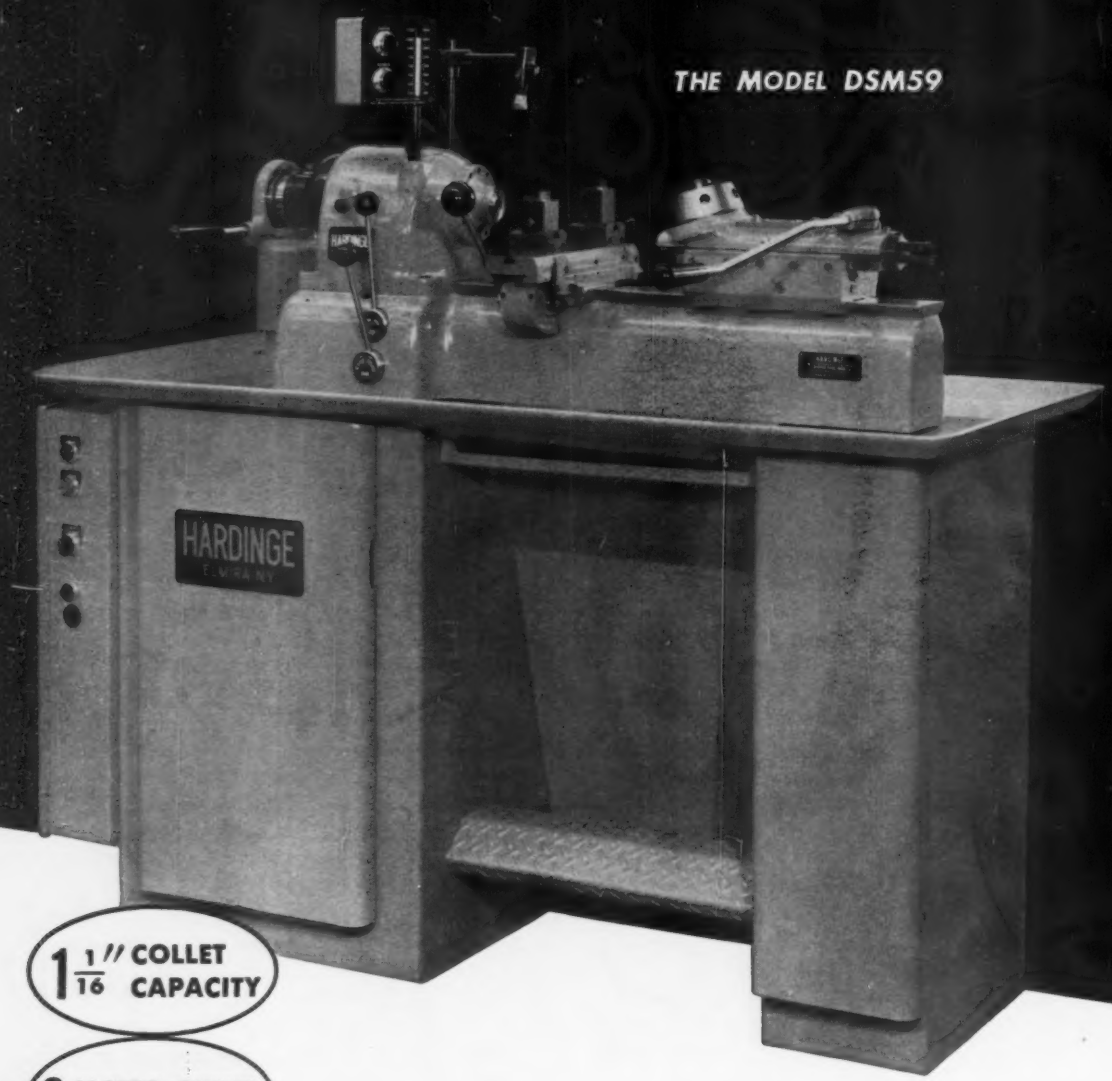
SPOT NEWS...

- **Wyman-Gordon is reverse impact extruding** what may be the nation's largest titanium extrusion—a 44-in.-OD, 39-in.-long, ¾-in.-wall-thickness part for the Minuteman rocket engine case. The Ti-6Al-4V alloy is being hot extruded on the Air Force 50,000-ton press at the North Grafton, Mass., plant.
- **Largest single foreign order ever for US-built machine tools** is said to be the automatic press line Clearing has built for Nissan Motor Company (Tokyo). Line consists of one 400-ton double-action press and five 400-ton single-action presses—all arranged for straight-through automatic work feed. Two men can operate the entire line. Production rate: 1200 fenders per hour.
- **Computer language programming for every GE Mark Century** numerical contouring control will soon be available to any user of the APT programming system. A library of specialized computer routines, to be known as the Marks Century Post Processor, is being prepared by General Electric. This will make it possible for any APT-oriented computer to translate English-language instructions into punched-tape programs for tools under Mark Century control.
- **Results of Lockheed-Georgia Co's 3-yr study of non-metallic tooling** for high-temperature metalworking applications are contained in a 487-page report to the Air Force. It covers development of cast refractory or ceramic draw dies; also stretchform and hydroform blocks, and heat-treating and brazing fixtures. Only in the draw die application did the non-metallics fail to withstand sheet-metal forming pressures at temperatures up to 2000 F.
- **New miniaturized computer, no bigger than a loaf of bread,** works at the speed of room-size computers. Developed by Burroughs Corp, the single-purpose brain holds 5500 electronic parts, weighs only 12 lb. Small triangular chips containing electronic circuitry fit between fins of a heat exchanger and plug into a flexible printed circuit board that folds around the heat exchanger.
- **High-purity, high-density single crystals of tungsten are now available** from Westinghouse Lamp Div (Bloomfield, NJ). New techniques have resulted in single crystals as large as 10 in. long and 0.22 in. in dia—large enough for small parts to be fabricated from them. Such ultra-pure crystals (99.9975%) have been rolled into sheets 3 ft long, ½ in. wide, and five mils thick. (For a similar development by Linde Co, see *AM/MM*—Jun 27 '60, p111.)
- **Superior Foundry Inc of Cleveland has decided to close its doors** after 71 years of operation. The company, which now employs 350, will close on Nov 10, says Walter Seelbach, president. He blames the profit squeeze, the high cost of workmen's compensation, the greater increase in wages than in productivity, and President Kennedy's request to "hold the price line."
- **Tantalum can be completely protected against hydrogen embrittlement** by mechanically attaching to it small quantities of platinum, reports Union Carbide Metals Company. In some cases, the area ratio of platinum to tantalum was as low as 1:10,000.
- **Over 150 possible profit opportunities in the Canadian metalworking industry** are spotlighted in a three-part industrial survey issued by the Ontario Department of Commerce and Development (Box M, Suite 1307, 680 Fifth venue, New York 19, N .Y.). Part one tells how US companies can establish manufacturing agreements with more than 750 Canadian firms now seeking such arrangements. Part two analyzes Canadian export opportunities, and part three points out major "fabrication gaps" in Canadian industry.
- **Automated robots helped reproduce themselves** at the opening of USI Robodyne Division's new Automation Center in Silver Spring, Md. These were TransfeRobot 200 units, fifty of which are now in use throughout industry. The new center, 57,000 sq ft on a 6-acre site, will produce only automation equipment.

HARDINGE
ELMIRA, N.Y.

FOR TODAY'S CLOSE TOLERANCE SUPER-PRECISION SECOND OPERATION WORK

THE MODEL DSM59



- $1\frac{1}{16}$" COLLET CAPACITY
- 6" STEP CHUCK CAPACITY
- 5" JAW CHUCK CAPACITY
- 3" INTERNAL CHUCKING CAPACITY

The ease and simplicity of operation of the DSM59 enables relatively unskilled operators to produce parts to close limits without expensive tooling.

480

HARDINGE BROTHERS, INC., ELMIRA, N. Y.

"PERFORMANCE HAS ESTABLISHED LEADERSHIP FOR HARDINGE"

WASHINGTON...

A revision in Bulletin F . . .

Bulletin F revision has begun, with the decision of the White House to give faster writeoffs to the textile industry. Textile firms have been given substantially faster depreciation schedules: Equipment with a Bulletin F tax life of 25-40 years can now be written off in 15 years; equipment with tax lives of 15-20 years can now be written off in 12 years.

But this is only the beginning. The administration has committed itself to similar revisions for other industries.

Growth industries will benefit most, since the administration is using as its basis for shortening tax lives the rapidity of technological advance and the swifter the rate at which machinery now becomes obsolete, even though not physically worn out.

Machine tool industry argument . . .

This means that the Kennedy administration has bought much of the argument of the machine tool industry, which has been fighting for years to get Washington to recognize that depreciation should be based not on physical life but on technological obsolescense.

This major shift was adopted at this time and in this manner as a result of Kennedy's campaign promises to do something for textiles. The industry wants protection or government help against imports; but the administration is committed for balance-of-payment reasons, among other things, to a program of less restrictions on foreign trade, not more. So the breakthrough on depreciation allowances is one answer to several complex problems.

Faster writeoffs will have several benefits, if Kennedy's hopes are fulfilled. He will gain support for his reciprocal trade measure, which must be legislated next year. More liberal allowances granted other industries will in fact help them modernize their plants and thus compete better in foreign markets and against foreign imports in the U S market.

A boost for the tax credit . . .

Also, the administration hopes that the decision to begin granting more liberal depreciation will gather in additional support for the 8% tax credit, which is still to be voted out by the Ways and Means Committee.

Business support for this incentive—also designed to stimulate modernization of productive equipment—has always been lukewarm. One of the reasons was a fear the Congressional approval of the tax credit would lessen the pressure on the administration for depreciation reform. Businessmen were skeptical that Dillon and Kennedy would actually liberalize depreciation allowances, as promised.

Depreciation practice studies . . .

The outlook is for the Treasury Department to complete its studies of depreciation practices, the studies which supposedly had to be in hand before depreciation reform could begin.

These are supposed to be ready by early next year. They will provide the Treasury with information showing (1) to what extent some firms benefit from faster writeoffs on equipment which competitors must write-off over longer periods and (2) the extent to which companies are already using the faster depreciation methods permitted by the 1954 law.

But the pressure will be on the administration to adopt faster writeoffs as soon as possible. The argument will be: Now that it is demonstrated how easily faster writeoffs can be given, in the case of textiles, why not quickly do likewise for other industries?

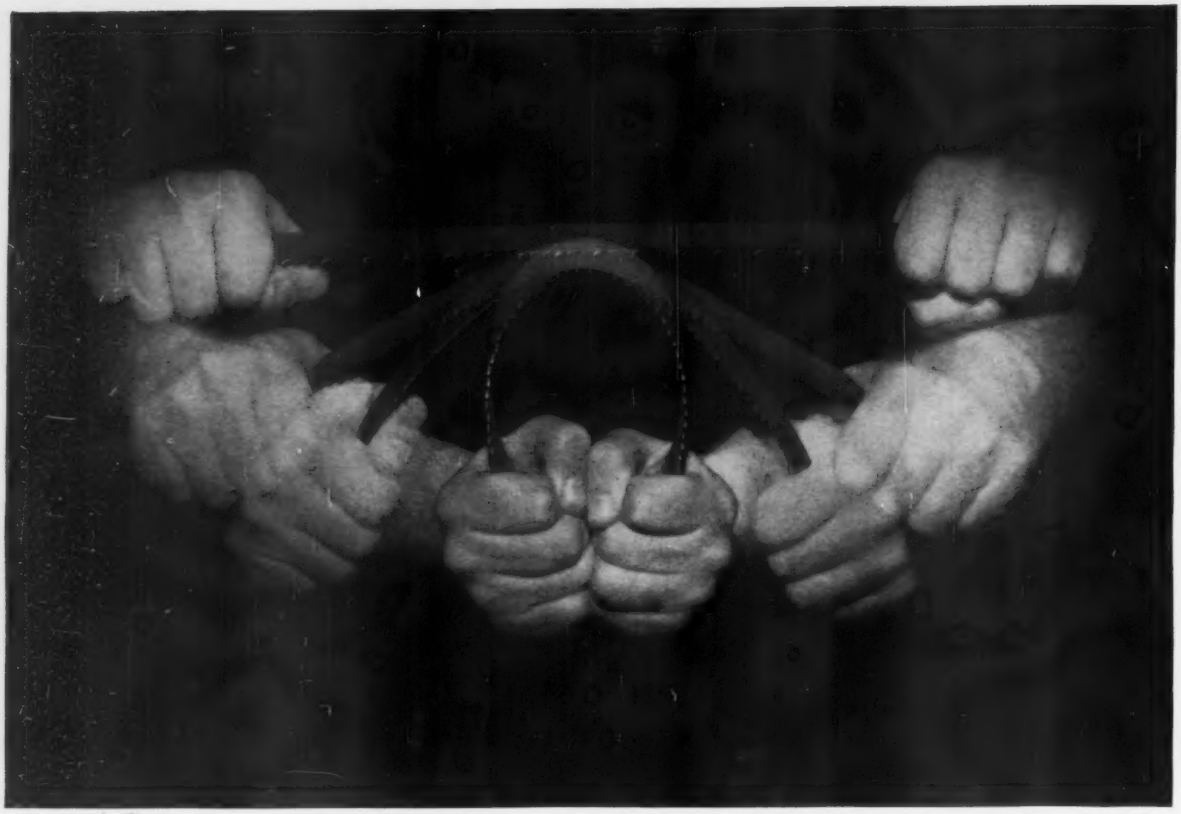
No further revisions now . . .

Treasury officials say flatly they will make no more Bulletin F revisions until they have presented the result of these studies to the Congressional committees, and gotten from them some guidance as to how to proceed from here on out.

The tax credit and depreciation reform are now politically mixed together, as far as the tax-writing committees of Congress are concerned. Both Senator Harry Byrd of the Senate Finance Committee, and Wilbur Mills of the House Ways and Means Committee will get a full understanding of the Treasury's plans for parceling out shorter lives to other industries early in the session. There's a very large question now whether the tax credit—and the $1.1 billion of revenue raisers that goes with it—stands a better or worse chance of adoption, now that depreciation reform has begun.

New regulations from IRS to the district offices and field agents will not be available for some time, apparently. IRS was caught by the suddenness of the decision and had to begin from scratch writing the instructions that agents will need to apply the new decision to individual companies that want the benefits.

◄ CIRCLE 310 READER SERVICE CARD



So it doesn't break---*So what??*

So we can bend a MARVEL High-Speed-Edge Hack Saw Blade double, and it won't break. Does this prove anything?

Let's see if it does. When you buy a box of hack saw blades, you expect each blade to have a reasonable cutting life. For example, take an ordinary blade that costs $4.00, and you expect it to produce 2000 sq. inches of accurate cutting-off before it is discarded. Would you be willing to pay $8.00 for that same blade? *You will, if it breaks halfway through its expected life.*

Bending a MARVEL High-Speed-Edge Hack Saw Blade to demonstrate that it is truly unbreakable proves the point that you get every square inch of blade life you pay for when you buy MARVEL Blades.

Safety to both operator and machine, plus maximum blade life, seem like value enough from this remarkable blade. However, these MARVEL Blades give you even more, for they will cut faster, with greater accuracy because they can be safely tensioned more taut in your machine than ordinary "breakable" blades and are therefore more rigid to resist deflection.

Cost? Unbreakable MARVEL High-Speed-Edge Hack Saw Blades are priced competitively. Use MARVEL Blades consistently with complete confidence because they have no equal for value. Leading Industrial Distributors stock and sell MARVEL. Ask yours today.

ARMSTRONG-BLUM MANUFACTURING CO.
5700 West Bloomingdale Avenue • Chicago 39, Illinois

MARVEL Metal Cutting SAWS
Better Machines-Better Blades

DETROIT...

Back to work at Dearborn . . .

Ford Motor Company received the lavish and undivided attention of the UAW during the middle two weeks of October, resulting in a production loss of something over 90,000 assembled cars. The length of the strike in days was curiously similar to the strike at GM; however, Ford lost less assemblies than GM because total output is lower. Current comparison is about 45,000 assemblies per week at Ford against over 70,000 per week at GM.

Checker Motors seems to have connected with buyers a little better lately; production is currently up some 50% (at 150 assemblies per week) compared to the 100-per-week level during spring and summer. A 50% kick-up is a whopper to any car manufacturer. In the case of Checker, it's simply the result of more orders, slanted a bit more than usual toward the "civilian" (non-cab) model. However, output at Kalamazoo still goes more than 90% to cabbies.

Studebaker is building about 2400 cars per week, which now includes their redesigned Hawk model. The luxury four-seater went into production in early October, which was unusually fast work, because the decision to redesign and produce it was made only this spring.

Chrysler Corp peaked at just over 20,000 vehicles per week. In late September Plymouth and Dodge production rates dropped off a bit as dealer showrooms started filling, but Chryslers and Imperials have been continuing on up. Chryslers are going at the rate of 2700 per week, and Imperial has climbed slowly to a present level of over 450 per week.

Truck production has been spotty, due partly to model changeover and partly to labor negotiations. Chevrolet and Ford both got up to over 8000 per week in September, Willys reached over 3000 per week, and International has been going strong at close to 3000 per week. The other big producers are GMC and Dodge, each making around 1600 per week (including GMC coaches).

Jigsaw puzzles . . .

One of the real problems in autoland this season has been to figure out where to produce the new-size cars with minimum retooling on assembly lines.

Ford is handling both Fairlanes and Meteors on the same assembly lines at Dearborn and Kansas City, Mo. But in Atlanta and San Jose (Calif) the Fairlane will be paired with the Falcon. Meantime, both Falcon and Comet will continue to be assembled at Lorain, Ohio, and Metuchen, NJ. All of these cars are unit-body construction, so assembly-line problems are more involved with car sizes than with differences in procedure.

Chevrolet has paired the new Chevy II differently; coupling it with the full-size Chevrolet in assembly plants at Framingham, Mass; Norwood, Ohio; and Kansas City, Mo; and with the Corvair at Willow Run; and Oakland, Calif.

Chrysler, not having introduced a new size this year, has no problem. Valiants and Lancers continue to be assembled at the Dodge main plant in Detroit (alongside another assembly line for Dodges) and at Newark, Del; Kansas City; and Oakland, Calif. Studebaker continues at South Bend, Ind; Rambler at Kenosha, Wis.; and the other GM divisions at their home plants and at seven BOP assembly plants across the country.

N/C via photographs . . .

Photogrammetry, the technique of combining stereo aerial photographs to create relief maps, may be the lever to get the auto companies into more intimate contact with numerical control. Applied to auto-body contours, it shortcuts some of the costly engineering procedure that converts a laboratory model into a body die for sheet-metal parts.

In process is a test run on a body model (reportedly a sample from Chrysler) that will be photographed, then plotted to establish exact contour points, converted to a drawing, and finally processed through a computer that presumably can produce a control tape for a die-cutting machine tool under numerical control.

Kucera and Associates, sponsors of a paper presented at the American Society of Body Engineers meeting in Detroit, say the technique is currently comparable in cost with conventional methods from model to drawing, and is faster and cheaper from drawing to finished production die.

Plastics for cars . . .

The interesting point about glass-fiber plastics applied to cars is that they have worked out just about as predicted—great for low-volume runs, not too great for high production. Thus, the Corvette, at a production rate of just under 11,000 units per year (up 6% from '60) is still an assembly of 88 molded glass-fiber parts, but no other US production car uses that much plastic. A few truck cabs are fiberglass (one White cab has 34 molded parts), and some plastic interior panels are being applied (as in Lincoln, Cadillac, and Valiant).

REMEMBER WHEN . . .

Doing The Job Fast Was Essential?

(AND DOING IT RIGHT WAS NECESSARY, TOO!)

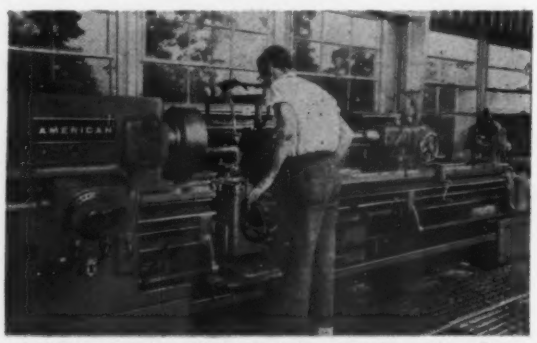
It still is!

As a manufacturer, you know that in this day of foreign competition and high material and labor costs, doing the job fast . . . and right . . . is critical. Many manufacturers are using machine tools built by The American Tool Works Company to knock hours off their precision machining.

For example, take Brown Oil Tool, Inc. of Houston, Texas . . .

A leading manufacturer of oil well completion equipment, Brown Oil Tool had a bottleneck in the production of hydraulically set retrievable packers from Timken seamless tubing. Releasing stems were slow to produce because of the complex shape and close tolerances required. Switching to an American Modulated Feed Tracer Lathe reduced machining time 750%! Handling plunge tracing as well as steps and shoulders, Brown's American lathe consistently holds a template-to-workpiece tolerance of 0.0005". According to Mr. Joe R. Brown, Vice President in Charge of Manufacturing, machining time on these packers was reduced from 2½ hours to 20 minutes floor to floor . . . and Brown Oil Tool has shown an across-the-board production increase of 50% on *all* jobs run on their American Modulated Feed Tracer Lathe.

If you would like *your* jobs done fast . . . and right . . . contact your American distributor. Or write to us for descriptive bulletins.



A leader in oil well production tools for a quarter century, Brown Oil Tool, Inc. uses an American Modulated Feed Tracer Lathe to produce precision hydraulic packers.

THE AMERICAN TOOL WORKS COMPANY

PEARL STREET AT EGGLESTON AVENUE • CINCINNATI 2, OHIO

#11

MACHINE TOOLS...

Major break-through in N/C . . .

Pratt & Whitney Co Inc, West Hartford, is achieving a major break-through in the numerical control field by introducing its new "Tape-O-Matic" N/C drilling machine priced at $8595.

This two-axis positioning machine will carry a 90-day money-back guarantee and a five-year warranty. It is available for cash, installment purchase, lease or under a trade-in plan that applies to all P&W machine tools.

To provide service for users of this machine, Pratt & Whitney is setting up a nation-wide network of tape processing centers, with an instantaneous teleprocessing system linking the various centers.

The bottom half of the machine with control cabinet is to be sold separately for non-cutting operations. Sample: the prototypes of this machine were used with programmed tape to numerically position and wire more than 5000 terminals in the drilling machine's control cabinet. Some 200 printed-circuit cards are plugged into these terminals within an area of 17 x 30 inches.

Pratt & Whitney has invested $1.5 million in developing this machine and tooling for its mass production. The first eleven of the Tape-O-Matics will go into P&W's own production line for manufacture of these N/C machines. Pratt & Whitney already has 30 N/C machine tools at work in its own plant.

"By 1967 half of the machine tools built and sold in this country will have numerical control, Paul N Stanton, P&W marketing vice president, predicts. He estimates that by 1965 Pratt & Whitney would attain this goal.

For a detailed description of the Tape-O-Matic, please turn to page 139.

$60 million for machine tools . . .

About $60 million will be spent by the three armed services for machine tools during the government's fiscal year 1962 ending next June 30, according to the best available estimate.

This estimate is based on a total expenditure of around $100 million for production equipment, of which 60% will be for machine tools. Each of the three services has its own definition of what constitutes "production equipment."

Close to half of the dollar commitments for production equipment in fiscal 1962 have already been made. That is why observers feel that the year's final figure for machine tool buying will get up to $60 million.

Skeptics still have their fingers crossed as to whether the program will end up as favorably as the present estimate indicates. Never in any year up to now, since the modernization program of the services was put into effect, has actual purchases of machine tools come near the minimum figure set forth in the program (2% of the original value of the government's machine tool holdings).

Washington officials point out that buying will be done on a low-bid basis. There is no assurance therefore that some foreign as well as domestic machines may not be bought.

100 machines on display . . .

One hundred machine tools from 16 builders were in operation at the recent nine-day show staged by Lemuel R Lance, Philadelphia distributor. About 3000 production executives and engineers are estimated to have visited the show in Lance's new permanent display building which has a continuous show occupying 7000 sq ft. Along with the show were five technical sessions. Because of heavy attendance, the session on tracer control was held twice.

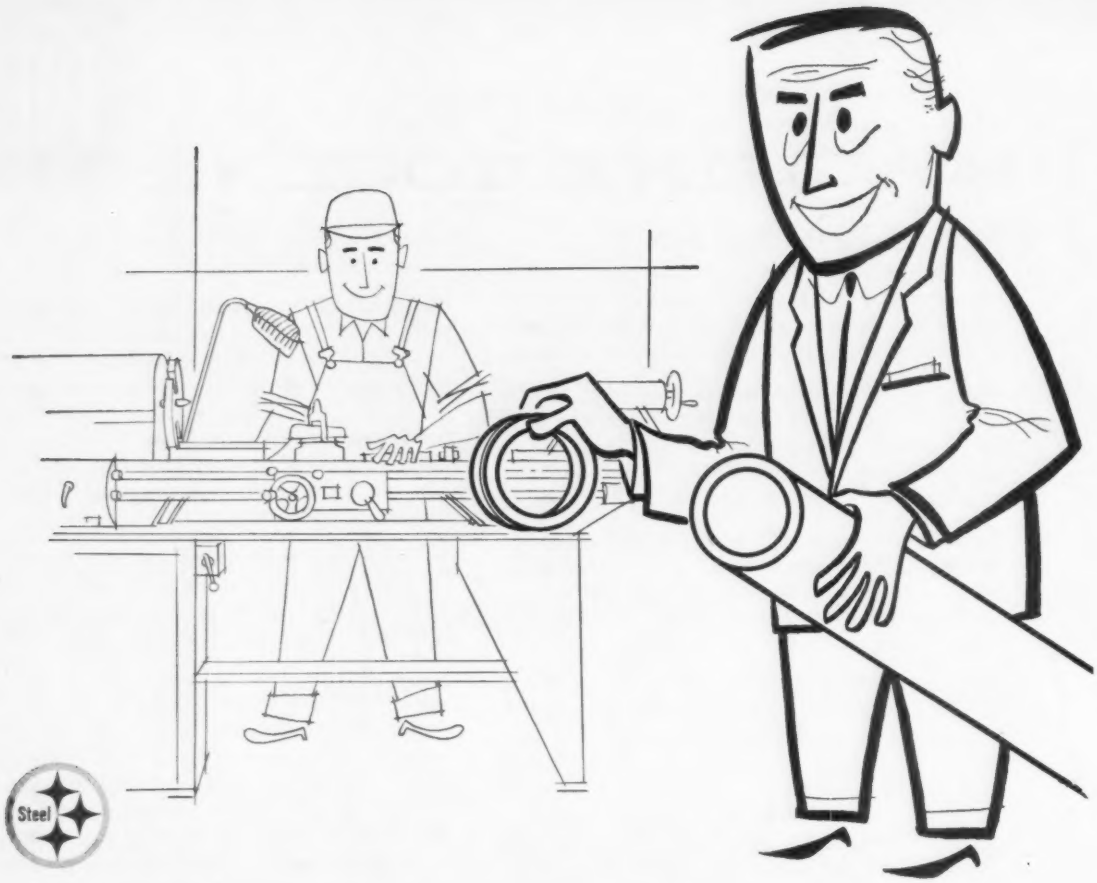
Rudolph Bannow, president of Bridgeport Machines, was the speaker at the opening dinner. Harry Blum, president of Armstrong-Blum, and William Adlet, vice president of Boyar-Schultz, spoke at the technical sessions. Lance operated free bus service to the show from cities as far away as Washington and Harrisburg.

Orders hit year's peak . . .

Net new orders for metal-cutting machine tools hit this year's peak in September—$56.75 million, topping 1961's previous high figure of $54.9 million, recorded in March. According to the National Machine Tool Builders' Association, September's $56.75 million represents an $11.95 gain over August new orders. Shipments rose from $34 million in August to $41.65 million in September.

Net new orders for metalforming machine tools rose only slightly—from $10.1 million in August to $10.55 million in September. Shipments dropped from $12.95 million in August to $10.45 million in September.

BF



YOU COME CLOSER TO FINISHED PRODUCT, REDUCE MACHINING TIME

when you specify B&W Job-Matched Mechanical Tubing

Do you consider tubing as a semi-finished product? It can be. In fact, when you start with the right B&W tube many end products require only finish machining—others need no machining at all.

Here's why. B&W seamless mechanical tubing is job-matched to your end-use application and production equipment. Desired finish, heat treatment, tolerances, alloy factor and steel quality are built into the tube to bring it as close as possible to the finished part. What's more, properties are uniform from tube to tube. You get fewer rejects —a more machinable tube in high-speed machining operations.

Interested? B&W mechanical tubing is available from Steel Service Centers around the country and through your B&W District Sales Office. Or write for Bulletin T-430. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1011-M

Seamless and welded tubular products, solid extrusions, rolled rings, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

TRENDS

MATERIALS...

Lighter-than-magnesium alloy . . .

Meeting in an atmosphere of industry optimism, the Magnesium Association opened its annual three-day meeting at the Belmont Plaza Hotel, New York City, with a highly significant technical session on the new lithium-magnesium alloys.

Research being conducted at Battelle Memorial Institute on alloys containing 11% or more of lithium was described by Paul D Frost. The new alloys are about 20% lighter than magnesium. Even more important, crystal structure is altered, making the material more ductile. As a result of the weight reduction and increased toughness, consideration is being given to these alloys for structural parts of missiles and space vehicles.

A new finishing system that promises to result in more widespread use of magnesium castings was described by R A Hagstrom, metallurgist of Raytheon Manufacturing Co, Maynard, Mass. Consisting of a four-step process which includes a unique fluoride anodizing treatment, the system prevents any possible foothold for corrosion or entrapment of water vapor or foreign particles beneath the coating.

Dent resistance of magnesium alloys compared with other materials was discussed by J A Gusack and D E Ritzema of Dow Metal Products Co, Midland, Mich. Tests by these men indicate that thin gage magnesium alloys have dent resistance comparable to or better than many aluminum alloys and mild steel. Furnishing original research data, the authors showed that one magnesium alloy has higher dent resistance than the other materials, whether the comparison is based on equal weight or an equal thickness of the sheet tested. Dent resistance has special significance for the design and construction of luggage, automobile parts, and containers.

Discussing investment casting of magnesium were Charles Pellegrini and Kenneth Herrick of the Tilton Division of Arwood Corp. They pointed out that many alloys are presently investment cast so that designers are no longer limited to AZ92A, nor in fact to the aluminum-zinc system. Alloys cast in the Tilton foundry are placed in four categories. Where elevated temperature exposures in excess of 200F are not to be encountered, the classical magnesium-aluminum-zinc alloys offer the optimum choice. AZ92A provides the best combination of tensile yield and ultimate tensile strengths. AZ91C provides the best combination of strength and ductility with a lesser tendency to microshrinkage than AZ92A.

AZ81A provides the best ductility with adequate strength and finest grain. AM100 provides a good combination of strength and ductility with a bonus of excellent soundness in pressure-tight applications. ZK61A, one of the zirconium bearing alloys, is relatively recent and is particularly notable for its strength-to-weight ratio which *exceeds that of any other casting alloy, ferrous or non-ferrous.*

For elevated temperature service, the zirconium bearing alloys with additions of rare earth metals or thorium, with or without zinc, have made magnesium competitive in exposures as high as 700F. For service up to 500F, EZ33A is recommended. For service to 600F, and intermittent loading to 700F, HK31A is suitable.

Refractory-metal oxidation . . .

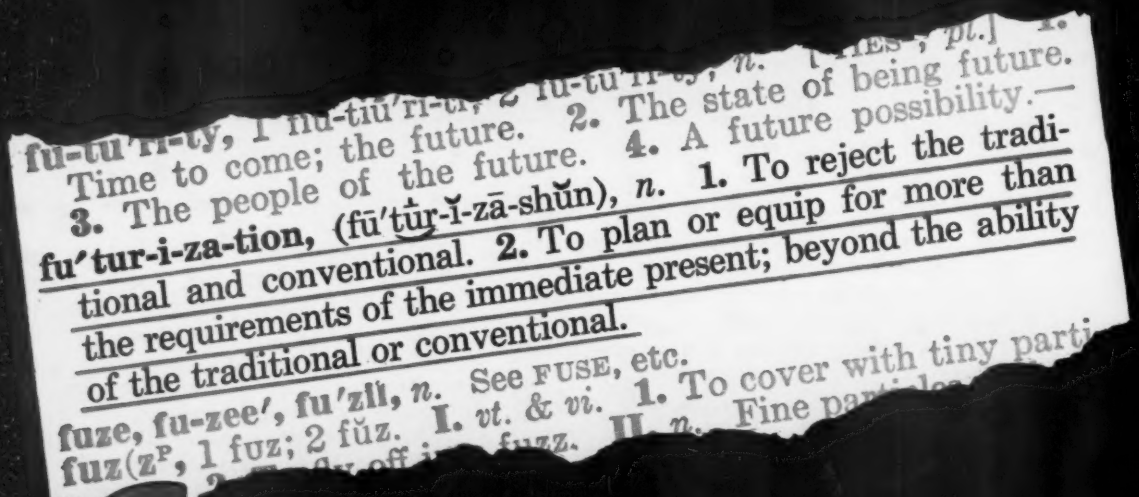
Systematic research into the resistance to oxidation of tungsten, titanium, and zirconium-base alloys is reported from the Soviet Union. The work is reported in the June, 1961 edition of Fizika Metallov I Metallodedenije. Alloys with 15, 50, and 75% titanium were tested.

Hardness of tungsten-titanium alloys was found to increase with the concentration of tungsten. So was their resistance to oxidation which at higher concentrations approaches the values for pure tungsten, and in all cases reaches its maximum at 700C. At this temperature, a protective surface film of tungsten trioxide is formed.

Tungsten-zirconium alloys with zirconium contents of 10, 30, and 70% were tested by the Russian group for resistance to oxidation in the temperature range of 500 to 900C. Hardness of these alloys was found to increase with rising tungsten content and their oxidation— for all tested ratios of alloying components—proportionally to the temperature of 600C. Above this temperature, a thick oxide scale formed, which, however, easily scaled off. In all alloys, the rate of oxidation is higher than in pure metals. Maximum resistance to oxidation was at 600C.

Noble metal composite . . .

Trilay is the name of a new noble metal composite developed by Englehard Industries, Inc, for the glass industry. It is composed of a layer of powdered platinum-metal alloy bonded between two outside layers of wrought platinum or platinum alloy. The material is used where platinum formerly was lost by solution into glass, etc. It has been used as the outer sheath of a swaged thermocouple and for melting pots.


Time to come; the future. 2. The state of being future.
3. The people of the future. 4. A future possibility.—
fu′tur-i-za-tion, (fū′tŭr-ĭ-zā-shŭn), n. 1. To reject the tradi-
tional and conventional. 2. To plan or equip for more than
the requirements of the immediate present; beyond the ability
of the traditional or conventional.
fuze, fu-zee′, fu′zĭl, n. See FUSE, etc.
fuz(z)y, 1 fuz; 2 fŭz. I. vt. & vi. 1. To cover with tiny parti

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WHAT'S AHEAD... in Metalworking

TRENDS

Steady gains through fourth quarter . . .

Production in the metalworking industry, as measured by the AM/MM Production Index, has risen to 105, up two points from last month's level.

Steel production is running slightly ahead of last month, but not as strongly as had been expected at mid-year. Reports from producers vary; one says production is very good, another is quite disappointed in this month's output. One warehouse has called off its 7.5% discount on stainless sheet. (This will bring the price back to first-quarter '61 levels.)

Automotive ordering of steel won't spurt suddenly. According to one steelmaker, the auto companies are saddled with cost factors which rule out overtime work to make up the lost output. (GM is estimated to have lost 140,000 units because of the strike.) Lost output will have to be made up at straight time, and this will spread the increased purchases over several months.

Auto parts manufacturers expect fair to good results for 1961. Original equipment manufacturers made a comeback in the second half but not enough to overcome a very slow first half. Replacement parts producers, however, see 1961 as a possible record year.

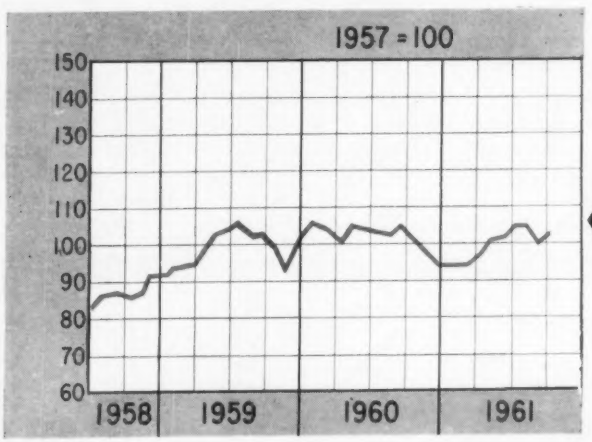
Screw machine parts producers are headed for a good year. The National Screw Machine Products Association reports that, for the first nine months of 1961, the new order index stands at 185, compared to 180 last year. Shipments are running behind last year, but if the industry can convert anywhere near its normal ratio of orders to quotes 1961 should wind up well ahead of 1960.

Orders for material handling equipment fell off 17 points according to the latest monthly index report from the Material Handling Institute. The decline, from 130.72 to 113.28 (1954-100), was strictly seasonal, and the outlook is still for 1961 bookings to exceed those of 1960.

Bearing manufacturers forecast that 1961 will be equal to, or just slightly under, 1960 business levels. Business hasn't changed much in the last six months, and right now is about on a par with that of 1960. Non-automotive business has been steady but unimpressive. Automotive business depends upon whether you're talking OEM or replacement. OEM market has been, and still is, disappointing; the replacement market continues to grow and will probably set a record this year.

The Gray Iron Founders' Society reports that member foundries operated at 66% of ideal capacity last month, and most of them expect business to continue at about the same level.

Reports from foundries (ferrous and non-ferrous), tool and die shops, and most other job shops, indicate that it's the man who goes out and looks for business that gets the gravy. In general, business is a little better now than a year ago, but profits are expected to remain at 1960 levels.

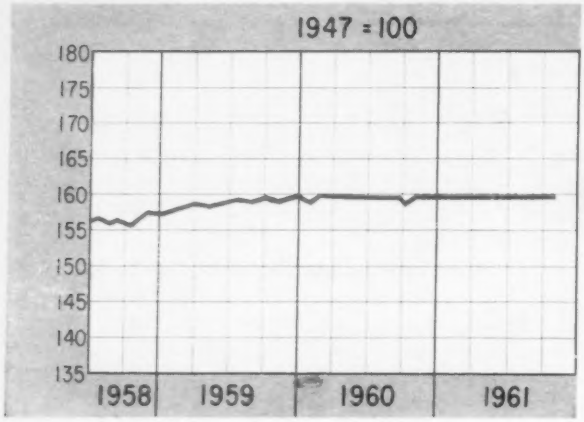


AMERICAN MACHINIST INDEX OF METALWORKING PRODUCTION

BASED ON MANHOURS WORKED IN THE FIVE COMPONENTS

	OCT Estimated	SEP Preliminary	AUG Revised	SEP Year Ago
Total Index	**105**	**103**	**107**	**107**
Machinery	101	102	106	
Electrical Machinery	116	118	112	
Autos	96	115	117	
Other Transportation	93	90	89	
Other Metalworking	109	113	109	

TRENDS WHAT'S AHEAD... in Business



AMERICAN MACHINIST INDEX OF METALWORKING PRICES

	OCT Estimated	SEP Preliminary	AUG Revised	SEP Year Ago
159.5 **Total Index**	**159.5**	**159.4**	**159.4**	**159.4**
Metalworking Machinery	**194.5**	**194.0**	**193.3**	
Other Machinery exc. Electrical	**174.2**	**174.2**	**173.1**	
Electrical Machinery	**156.6**	**156.7**	**158.7**	
Fabricated Metal Products	**147.1**	**147.1**	**145.2**	

Autumn roundup . . .

Autumn is the traditional time of the year for football and feasting, and it is also the time of year that an annual rite in the business field begins. Each fall a spate of forecasts of business conditions for the following year comes forth. Some of the forecasts are carefully contrived and well worth listening to; others are merely a torrent of emotional rhetoric.

Before you can make head or tail of any forecast, however, you need to know where the economy stands now. Accordingly, this article deviates from the usual pattern of gazing into the crystal ball to review the year just finished, from the third quarter 1960 to the same quarter this year.

Looking first at the summary figure of total national income and production—gross national product—reveals a 4% increase to a dollar volume in the third quarter just finished of nearly $526 billion. Not surprisingly, the most rapidy growing portion of GNP was the government sector, with an 8% increase including federal, state, and local governments. Mr. Khrushchev's splenetic attitude recently has given a decided lift to national defense spending. The figure for national defense was just about an even $50.0 billion dollars in the third quarter, up 10% from a year earlier.

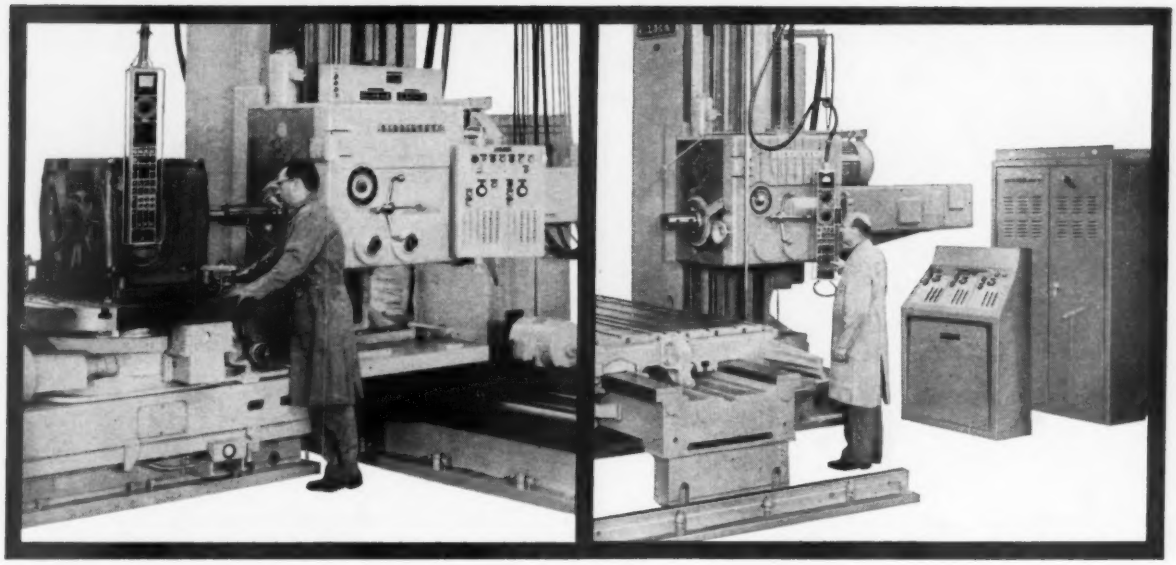
Turning now to the private sector of the economy, we find smaller gains than in the government area, because of the recession during the winter. Consumer spending, the largest single chunk of total spending, was up only 3%. A decline in spending for consumer hard goods, refrigerators and the like, was more than compensated for by an increase in soft goods, and that real growth area, consumer services.

In the investment area, a cut of 7% in business spending for machinery is balanced and then some by a rise in commercial and residential building.

WEEKLY BUSINESS INDICATORS	*Latest Week*	*Preceding Week*	*Year Ago*
Business Week Index of Activity (1947-1949=100)*	158.3	158.1	148.0
Steel ingot operation (thousands of tons)	2.071	2,102	1,579
Electric power output (million Kilowatt hours)	15,125	15,035	14,120
Production of automobiles	97,329	102,098	144,056
Engineering construction awards (*Eng. News-Record*—thousands)	$79,115	$70,243	$77,374

MONTHLY BUSINESS INDICATORS	*Latest Month*	*Preceding Month*	*Year Ago*
Index of industrial production (1957=100)*	112	113	107
Index of durable manufactures production (1957=100)*	105	108	102
Durable goods manufacturers' sales, billions*	15.19	14.79	14.42
Machinery manufacturers' sales, billions*	5.04	4.88	4.70
Durable goods manufacturers' new orders, billions	15.56	15.03	14.41
Machinery manufacturers' new orders, billions	5.12	4.89	4.81
New Orders for Nonelectrical Machinery (1950=100)*	191	186	174
New Contracts for Industrial Construction (1950=100)	96	110	149

* Seasonally adjusted



Gilbert horizontals make the most of tape

Increased output per man and machine, improved and uniform accuracy, reduced tool and fixture storage, reduced parts inventory, shortened lead time, fewer inspections—all make a tape-controlled horizontal pay for itself fast, *if the horizontal is built to work with tape.*

To get increased output, your horizontal must be basically designed (as a Cincinnati Gilbert is) to take increased operation. To get improved, uniform accuracy, your horizontal must be built (as a Cincinnati Gilbert is) to eliminate uneven wear of ways, guides, and screws.

Tape can be "tacked onto" any horizontal boring mill; but it will pay off best when it is teamed with a Cincinnati Gilbert, designed to make the most of tape.

New 4″ and 5″ series are built for tape

Both the new 4″ and 5″ series, table and floor type, are designed—from foundation up—to match the potential of tape. Exclusive LIFE-LIGN construction of ways and guides eliminates cocking of all moving units. No matter how hard you run a Gilbert under tape, you can be sure that every unit moves straight and smooth as the tape commands.

Spindle diameters are 3½″, 4″, or 5″. Vertical and horizontal travel of units can be varied. Multiple work stations increase production.

You can get any degree of numerical control you need, from simple dial-in operation to three-axis control of the machine and automatic table indexing.

Write for new literature. The Cincinnati Gilbert Machine Tool Co., 3366 Beekman Street, Cincinnati 23, Ohio.

Cincinnati

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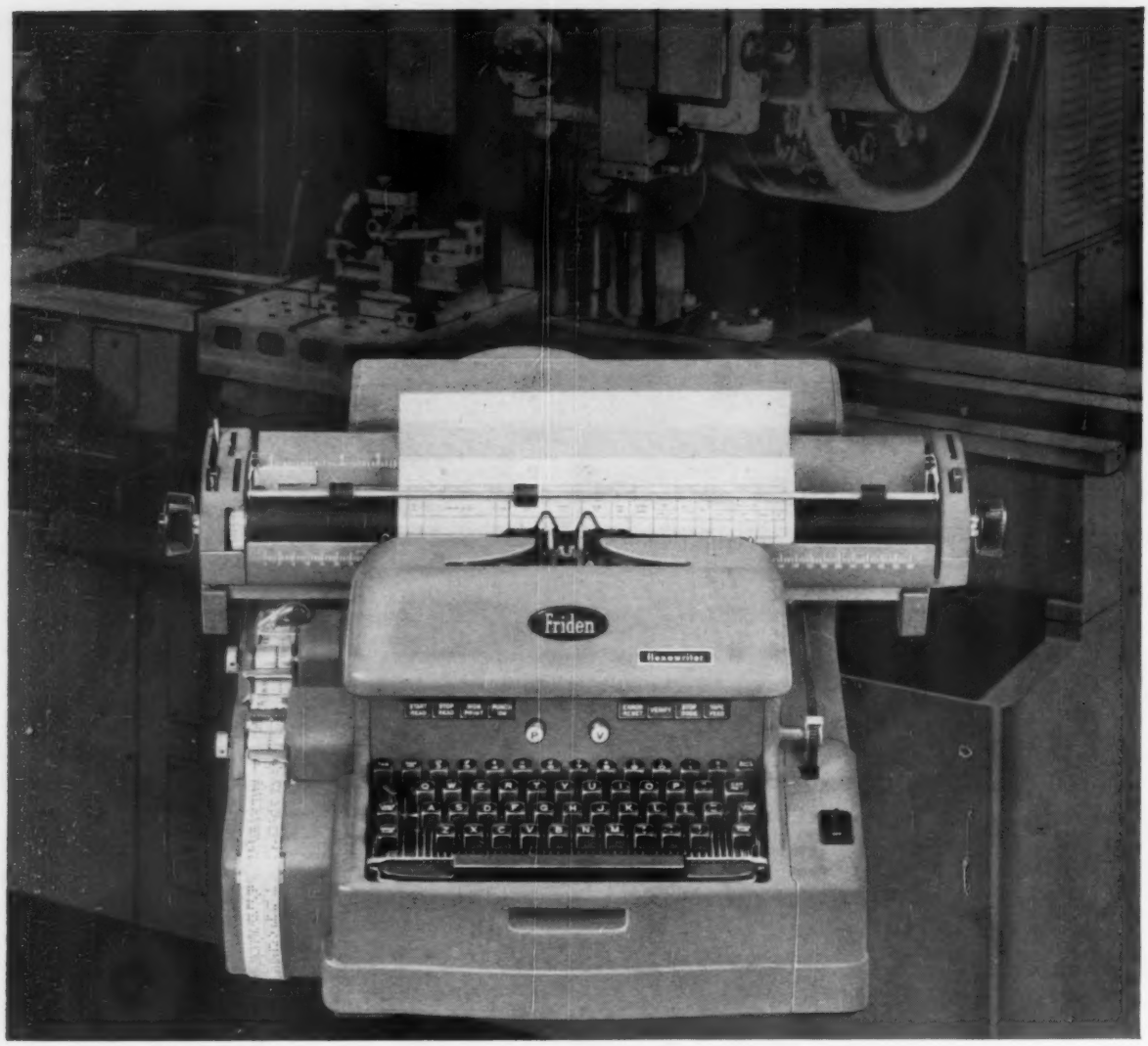

Why Kearney & Trecker chose 8-channel punched tape input

The Kearney & Trecker Milwaukee-Matic is a remarkable tool even without numerical control. With NC, it's close to revolutionary. This automatic multi-machining center permits fast, economical small-lot manufacturing with minimum planning, far less lead time and dramatic reductions in tooling and inventory costs.

One major key to Milwaukee-Matic efficiency is the input. Kearney & Trecker picked 8-channel punched tape for reliability, durability, accuracy. And one thing more: ease of preparation on the Friden Flexowriter®. The Flexowriter has a standard typewriter keyboard. The operator (any competent typist) prepares a *visual* proof as she makes the tape. The machine parity-checks each code automatically. And finished tapes can be double-checked (or quickly duplicated) by running them back through the Flexowriter's reader.

Along with Kearney & Trecker, the great majority of machine tool manufacturers have already standardized on 8-channel punched tape input. Take it from them: punched tape is the best NC input. And in punched tape, Friden is the leader.

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American Machinist | Metalworking Manufacturing ESTABLISHED 1877

Why Not a Full Job?

Like a breath of cold, crisp air in a hot, stuffy room. That is the effect of the White House's announcement that the textile industry will be permitted faster writeoffs of new machinery.

Bulletin F's 1942 list of useful lives no longer is sacrosanct. Drastic reductions are being made in textile machinery lives—from an unrealistic 25-to-40 years down to 15.

This surprising action . . .

is based on doing something special to aid the sorely-beset textile industry. The reasons for it make interesting reading.

"The textile industry is experiencing a major technological breakthrough," the White House statement says, "in which advancing techniques engender further advances and make even recently developed equipment economically outmoded long before it is physically worn out."

The White House pronouncement goes on to say that "the pressure for adoption of technological innovations is accentuated by competition of foreign producers who, in many cases, enjoy the advantages of very liberal depreciation allowances as well as low wage costs."

In an over-all statement about the new ruling, the White House said that it "will be of significant help to the industry in enabling it to modernize, meet foreign competition and provide jobs."

The Treasury is said to be . . .

studying the need for similar faster writeoffs in other industries than the textile industry. Back in mid-1960 the Treasury began a broad study of equipment depreciation in all industries.

Up to now Treasury has steadfastly maintained that it could take no action about revising Bulletin F for liberalizing depreciation in any form without the specific approval of Congress. What has happened in the textile case is an about face in this policy.

If the criteria applied to the textile industry requirements are used to measure what should be done for other industries, the benefits now being extended to the textile industry should be widened in scope to take in all of Metalworking.

Our AM/MM 1958 Inventory of Metalworking Equipment showed that the nation's production machinery is getting older rather than younger. This year AM/MM editors estimate that U S metalworking equipment, on the average, is still older than in 1958. Unless there is a radical reversal in buying policy, it will be even older, more obsolete and less efficient in 1962 and 1963.

All of this in face of . . .

the fact that no technological breakthrough, in textile machinery or anywhere else, has been greater the past few years than in metalworking production equipment. In the metalworking field, the new techniques have come so fast, that, as the White House said about textile machinery, "even recently developed equipment has been economically outmoded long before it is physically worn out."

Nowhere is the need for modernization more imperative than in Metalworking. If manufacturers were allowed to depreciate their new machinery investments faster, they would have a sound reason for modernizing.

The first and logical place to begin equipment modernization is to modernize Bulletin F. If the portion of it pertaining to textile machinery is put into today's world instead of that of 1942, why not do a full job of it?

Burnham Finney EDITOR

They "Go Together" For

CENTRALIZED POWER CONTROL for manual operation and **NUMERICAL TAPE CONTROL** for automatic operation provide complete versatility of the Bullard DYNAMILL H.B.M. to insure maximum production.

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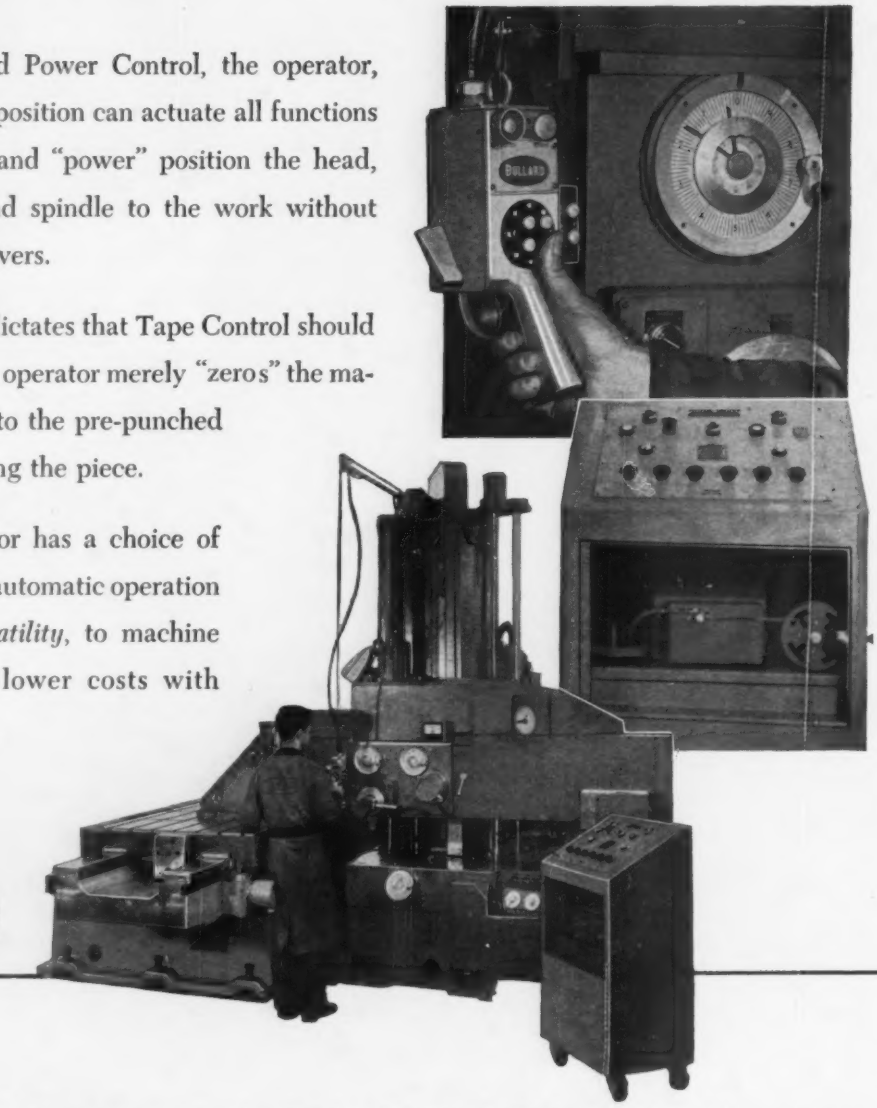

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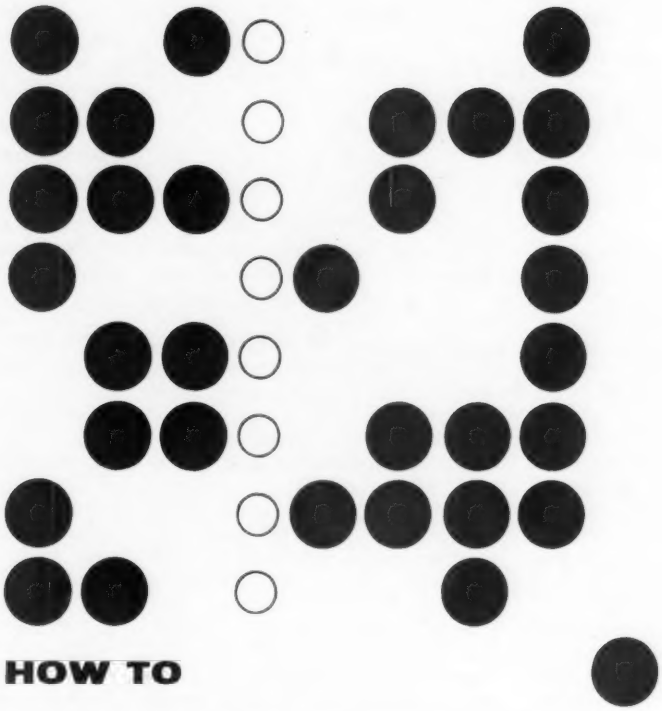

HOW TO

PROVE THE PROFIT

IN NUMERICAL CONTROL

By William M Stocker, Jr, senior associate editor

Numerical control has come of age. Right now it is in transition from an extensive development phase. Production applications are accelerating. Today, more than 2000 numerically controlled machines are profitably producing metal parts.

Can you profit by numerical control? Is it practical for the kind of business you are in? Where do you start? When does N/C equipment apply?

How can you decide its worth—first for yourself, and then to convince others who may share your responsibility or who must approve a budget? Conventional comparisons are inadequate; standard formulas rarely reflect all of the considerations.

By considering the effect of this concept on the total plant economy, this report provides a sound approach to selecting and justifying, and financing, numerically controlled equipment. It will help you reach a sound decision.

American Machinist / *Metalworking Manufacturing*

Special Report NO. 513, October 30, 1961

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Can you price-out progress?

If you are responsible for the profit in manufacturing metal, and allied products, you are invited to enter the new world of numerical control. With more than 2000 numerically controlled machine tools now producing parts, this new world is far from unexplored.

Life is full of entries and exits. Every day you cross thresholds into new worlds, into new parameters of existence, never before experienced. Sometimes you enter only if you choose. At other times you have no choice—or find yourself involved without realizing what has happened.

Whenever you enter a new world by your own choice, you are a pioneer. You have made the decision to accept the unknown, the risks, for some anticipated reward.

Numerical control is here. Many companies in the metalworking industry are profiting substantially by its use. These profits have been realized through reduction in lead time, reduced tooling costs, higher productivity, decreased need for inspection, increased accuracy in the completed part, improved reproducibility from part to part, plus a whole series of intangible savings.

Perhaps you are among the pioneers already in N/C, but the chances are much greater that you are weighing your need to enter. Can you afford it; can you ignore it? One of the more important decisions in your business life, the answer calls for sound reasoning based on a thorough knowledge of conditions.

Needs an interpreter

In spite of several years of experience, hundreds of published articles, and countless meetings and seminars, most machine-tool users still fail to understand the implications of numerical control; can't describe them to accountants.

One of the major causes of this misunderstanding appears to be the lack of a common language, or even clear communication, between the manufacturing- and the financial-management levels of many metalworking companies. Tradition keeps financial people from recognizing the revolution that is underway.

Manufacturing executives, too, still tell us that their order quantities are too small to warrant numerical control, when it has been stressed repeatedly that short runs, even single pieces, are the forte of this concept. One reader writes to ask us why we publish so much on numerical control when ". . . 95% of your readers can never afford it." Have we failed him—or is he failing himself?

Cost is not the only consideration. Not all numerical-control equipment is expensive, though none of it is cheap. Some of the most productive equipment is very costly—and very profitable when properly utilized. But cost should not be your first consideration. Determine first the type of equipment you can use most profitably. Then translate the manufacturing-time advantages into dollar advantages. Perhaps you will find no advantage in N/C.

At this point you may be ready to ask, "How much will a ticket to this new world cost—and where do I get the grubstake?"

Nothing ventured . . .

Because numerical control still moves in the world of pioneers, some of its benefits are difficult to evaluate. The dollar advantage is not as readily determined as when a new model of a conventional machine tool is compared with an earlier model of that machine. For numerical control, there is no comparable evaluation technique and there is no historical record for comparison. Virtually no experience predates 1955. Most of the equipment in use today was bought with a large measure of speculation.

Some applications of N/C have been extensively proved in practice already. Though it cannot guarantee your profit, this experience will strengthen your assurance of success in using this production-proved equipment. Your risk is reduced.

Other applications, perhaps more profitable than any to date, have yet to be thought of. You may be the person to propose one of these ideas. Just what these potential benefits are, you can't prove. Yet you know that inherently numerical control will give you far greater capabilities than your present equipment. The problem is, how do you justify an expenditure for this equipment? How do you put a price-tag on progress?

To buy, or not to buy . . .

Metalworking equipment buying falls into several categories. Probably the three principal reasons for acquisition are:

1. To replace obsolete equipment to improve productivity and/or quality.

2. To expand production capacity or increase capability.

3. To establish a new plant, production facility, or product line.

New equipment for expansion or initial installation is not nearly as difficult to justify, in the eyes of the purse-string watchers, as replacement equipment. For one thing, the company expects to invest some money. It wants the best possible return.

Also, when an expansion program is launched, it usually means prosperity or at least optimism. Management will spend a little more to get the best possible manufacturing result. And, there is no existing equipment, or tooling, to offset the advantage. An acquisition program can be followed. Direct and indirect costs are being scrutinized at all levels of responsibility. Satisfactory performance is mandatory.

Under these conditions, when numerically controlled equipment is feasible its justification is relatively easy. By basing justification upon projected workload of specific pieces, and remembering to include all of the indirect and intangible benefits, a truly convincing picture can be shown. Most of the data are available if you know where to look.

Management is not against numerical control—or any other method of improving the profit—so much as it is against change. And, to a degree, this is understandable. Profit percentages today don't permit much recovery of misapplied technological speculation. The problem is not so often the high cost, or lack of funds, as what your dollars buy.

Routine questions are causing most of the misgivings: Can we find enough work to keep the equipment busy? How much time and money will it take to train efficient programmers and operators? Will I have to hire maintenance specialists to keep the units working? How much standardization of equipment is essential to efficiency? Will I bring on labor troubles? Lack of knowledge creates fear.

Previous *AM/MM* reports and arti-

The profit target...

The real vehicle to profit is the product, not the plant. Economically, the prime target of manufacturing management is to reduce the total cost of manufacturing a part or a product, not simply to reduce the labor involved or to gain some other short-term goal.

Analyses of the volume increase needed to reach a specific volume goal—and the cost decrease demanded by a specific cost goal—may be the most effective weapons to force into view new profit opportunities by investment in new, enlarged, or different facilities.

Until marketing goals are established, the value of technical advancements cannot be determined. Profitability depends upon utilization.

cles answer most of these questions. Equipment suppliers and many people now using numerical control in production can provide experience-backed information in great detail. Today, there is no excuse for ignorance about N/C. Instead of making a decision on hearsay, or judging by conventional standards, ask the man who has N/C. Chances are he's planning to install more.

Two Categories

Remember that numerical control in production is barely five years old; that there are two categories of equipment: One category covers prototype installations, the other category represents production-proved equipment.

Many prototype installations have proved extremely profitable to their owners. But prototypes, generally, require more engineering and debugging time; are difficult to estimate and anticipate. Much of the criticism voiced about numerical control stems from developmental problems in prototype systems. As with any new operation, there is a "learning curve."

Even with 30 to 40% downtime, and a lot of frustration, that first machine is in production and showing a profit long before its second counterpart is ready to work. Operating only two-thirds of the time, the prototype still will outperform conventional equipment by a healthy margin—and improve its productivity from that level.

Surveys of users who have gone through the prototype pains show overwhelmingly that the equipment has proved worthwhile in spite of the problems and delays. Of course, accumulating experience is reducing this condition.

Standard numerical-control equipment is offered by many companies. These are the machines that prototypes made possible. Bugs are minimized. Installation and production-readying require only a few days or a few weeks. With proper advance planning, parts are in production sooner than would be normal for a new conventional machine.

"Bumping" an obsolete conventional machine with numerically controlled equipment is the most difficult category of acquisition. Why replace the old, reliable machine, practically paid for, with this new-fangled stuff? After all, the machine is a working asset.

Asset or liability

Question: Is it an asset? On the books, maybe. But is that conventional machine providing the best possible return on its worth? How much support is required in skill, tooling, setup time, supervision, and inventory accumulation to make this machine function? How much of the value this machine adds to your product is returned to you as profit; how much of the value is expense? How many times a year will it turn over invested dollars?

If this "asset" is preventing the acquisition of a substantially more

Numerical control pays when...

- The number of operations or machine setups is large.
- Machining time is low in relation to setup time.
- Lead time must be cut, is normally long, or seems excessive.
- Machining operations are complex.
- Complex parts must be made in short runs.
- Parts are subject to frequent design change.
- Part complexity makes frequent human error likely.
- Wide variations in part design, function, or dimensions create the need for a costly and space-consuming inventory.
- Tooling costs are a substantial part of total manufacturing costs; especially when new tooling is needed.
- Plant expansion is contemplated to provide room for increasing capacity by addition of general-purpose machines.
- Decentralized plants, or service shops, must exchange tooling or manufacturing data to produce identical parts.
- Competitors in your business, through the use of numerically controlled equipment, are quoting better prices to your customers.

productive machine, capable of adding more value at less expense, it is, in fact, a liability. It is an "account payable" against your company's profit potential as long as it remains in service.

Should you buy numerical control? Only you can decide. First you must determine whether the parts you manufacture are most appropriately worked on this kind of equipment and which parts. What lot sizes are most practical? What tooling is involved? What shapes are specified? What accuracies? What is the demand for the future? Will numerical control change your make-or-buy policy?

Then you must select the most suitable equipment to meet your requirements. How much numerical control do you need? Does the job require a multi-operation machine? Is your work load sufficient to carry the cost? What equipment characteristics seem most essential? What operations will precede and follow the operations on the numerically controlled equipment? What auxiliary functions are necessary? Should you start with a simple system and work up—or is the profit potential in a more complex machine too good to postpone?

Of course, these questions are only typical of many you must ask, and answer. If you do a thorough job of analyzing your requirements, and if N/C seems practical, careful selection of the equipment will simplify its justification. In turn, a carefully justified proposal will improve your ability to obtain financing, when it is desired.

The cost of your time spent in gathering and preparing this information will be money well invested. Even if you decide against using numerical control, you will have a new insight of your company's manufacturing performance; a better understanding of all the influences on cost and profit. Significant areas for improvement will be spotlighted.

Course in management

Out of these detailed studies will emerge better managers, equipped with the knowledge needed to meet the challenge of intertwined technology and economics in the years ahead. And, unlike any previous manufacturing development, numerical control unifies all the company's functions into a more effective business team. This intangible is invaluable.

How to select N/C equipment

Realizing that there may be something to gain by numerical control, reading of the success other manufacturers are finding with numerical control, how do you prove there is profit in this concept for you? First, unlike the men who still tell us their production isn't sufficiently high to warrant it, you must learn all you can about N/C. Then you must take a completely fresh look at the products you are making and at the manufacturing methods you are using. You must review the products, markets, and methods you anticipate for tomorrow.

Study plant economy

As never before in the acquisition of manufacturing equipment, you should take into account *the entire plant economy*. If your company has been doing an adequate job of cost accounting, the study will be much easier and more accurate. But a complete set of figures is not essential. Be objective in your study. Remember that from the time you pay for a piece of raw material until you are paid for it as a finished product it is costing you money every minute. Consider that the $20 per hour charge for a milling machine may represent only 10 to 20 minutes of actual cutting time in each hour. To see where your money really goes, break the actual cost of some typical parts down into all of the elements that contribute to it.

You may be inclined to say, "I bought a fine new boring mill two years ago for $40,000—why should I pay $120,000 for one this year just because it has numerical control?"

The answer is that when numerical control is included you are not buying a boring mill. You are buying a machining system. And you are not spending $80,000 for a control system. At least half of the total price is for a sturdier, more accurate, more sophisticated machine tool that can operate efficiently under numerical control. But the machine tool and the control should always be evaluated as a packaged system.

What does this "machining system" offer? People presently using such equipment say it is producing three to five times the work of conventional boring mills. They say scrap is virtually eliminated, hence inspection time is reduced to spot checking. Layout is unnecessary. Setup time is minutes instead of hours. Complicated and expensive fixtures are replaced by simple locating plates, or just by clamping. More exact duplication from part to part speeds assembly operations. Cutting-tool cost per piece is greatly reduced.

All this success is encouraging, but it doesn't prove that your application of N/C will be as profitable. For a clearer picture, select a few typical jobs from your own shop. Analyze each of them and detail all the time and cost elements to produce each part by conventional methods. Then have each job programmed for production by numerical control.

To use numerically controlled equipment profitably, you must know precisely what you want it to do, and where you want this job done. There is a simple, effective way to specify your requirements, but it may take getting used to.

Analyze the job

Shocking as the thought can be, think of numerically controlled equipment as a potential employee rather than as a conventional machine. Remember that you are dealing in skills rather than in muscle. *Write a job analysis* for the equipment, to describe the capabilities you need. And don't determine the classification until all of the other requirements are established.

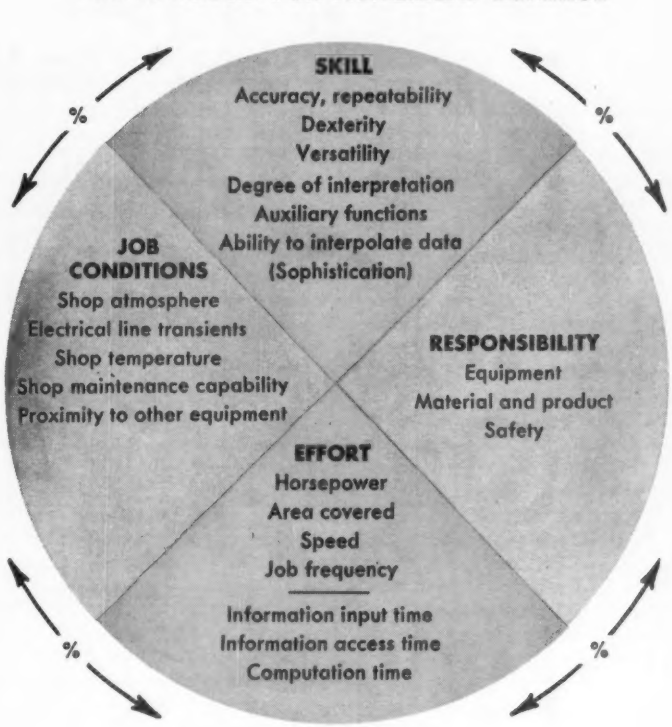
Do you need a first-class, all-around machinist or a semi-skilled operator? While numerical control can provide combinations of physical abilities impossible in a human employee, it still is valuable to list your requirements in the order of their importance. Thus you can assemble the equipment characteristics which offer the most effective package at the least cost. Also, you have a basis for comparing competitive equipment, for studying related op-

erations, or for making sound compromises.

"Job analysis" generally covers job description, job specification, and job classification. Handling analysis in this order will minimize the danger of prejudging requirements. Prepare a worksheet (p113). It may parallel but certainly won't duplicate the forms used for human-job analysis. Make the form as sound and complete as foresight will allow.

"A job analysis," wrote Ralph C Davis years ago, "is an investigation and analysis of a *work assignment*, and the *conditions surrounding it*, to *determine its requirements* from an *organizational standpoint*. In this respect it differs fundamentally from time and motion study." Could any words more aptly state what you need to know to select an N/C system? He was writing, of course, about the analysis of jobs for people.

The greatest help, and the first requirement, in selecting any kind of manufacturing equipment is a sound cost-accounting system. A true picture of what each element in the piece now costs is especially helpful in justifying the selected numerically controlled equipment.



Best cost system

Machine-hour rate, or facilities costing, is an excellent system for supplying this information. It applies a specific hourly rate to each unit of manufacturing equipment, or to "cost centers" comprising groups of identical units. The hourly rate can be divided by the average number of pieces produced per hour to show you exactly how much each piece costs to process on each unit of equipment.

Burden is included in this hourly rate, apportioned by the value of the unit to which it is applied. However, machine-hour-rate costing strives to minimize general overhead by applying every possible direct cost to a specific unit of equipment. Ideally, each manufacturing unit carries its own floor-space rent, preventive-maintenance charge, direct-labor cost, utilities costs, depreciation allowance, etc. Each unit includes a basic interest rate, such as 6% per year, to pay for the undepreciated worth of the equipment (installed cost less accumulated depreciation) plus a profit factor.

Unfortunately, machine-hour rate is relatively new and too few companies use it. Far more common is the inexact, general-overhead method which lumps all the indirect charges together and applies them as a percentage of direct-labor costs.

Never economically sound, this general-burden method was started years ago when metalworking plants were less complex and indirect charges were a small fraction of the direct costs. In the 1940's a 150% burden was on the high side. Today, burden applied in this way runs from 150 to 400% or more. Still it is charged as a general, undefined rate. Hourly rates bear absolutely no relationship to the actual cost of individual machine operations. Cost per piece is an arbitrary myth of no value whatsoever in comparing present practices with proposed improvements.

Example: Install a numerically controlled machine for $50,000. Establish a direct labor rate for it of $8.00 per hr. Put it on the same work as a conventional machine worth $10,000 and rated at $6.00 per hr. Multiply both hourly rates by 400% burden. Now the N/C machine costs $32 per hour and the conventional machine cost $24 for the same time. But the N/C machine produces four times the work of the conventional machine.

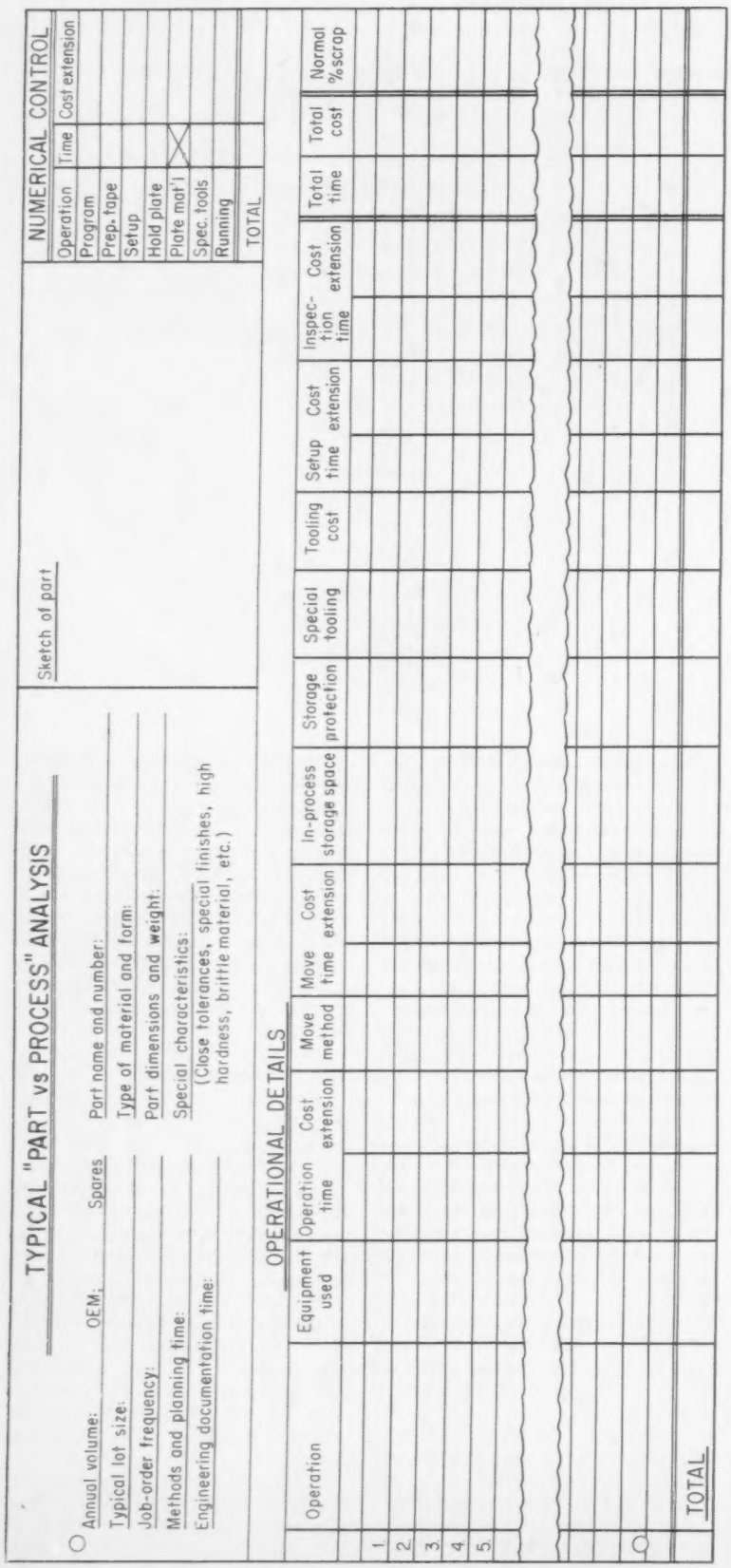
Figures look good for N/C. It takes four conventional machines, worth $40,000 (or $96 per hr), to do the work of one N/C machine at $32 per hour. Then along comes the same accountant who installed the burden system, and he asks, "What's the pay-back on that N/C machine?"

Let's see: Two shifts (4000 hr) at $32 per hour is $128,000 less 10% downtime is $115,200 netted by N/C. Then 4000 hr at $96 per hr for the four conventional machines is $384,000 less 10% for downtime is $345,600. Subtract $115,200 and the N/C machine has saved $220,400 in one year. It has paid for itself in three months—or in six months after taxes!

How is burden shared

Or has it . . . ? Where did these costs come from? Should both types of equipment share the same burden? Each of the conventional machines is carrying three-quarters of the operating overhead of the N/C machine. Yet it is worth only one-fifth as much. It takes only half the floor space. Doing only one-quarter of the work, it can't use as much power or wear out as many tools. As it is less productive, so it requires less service from shop materials-handling people. When it is down for repairs or for lack of work, the conventional machine does not accumulate debt as rapidly.

For argument—and this example is greatly oversimplified—let us say that a fair cost-center rate for all four conventional machines, based



TYPICAL "PART vs PROCESS" ANALYSIS

Annual volume: OEM: Spares
Typical lot size:
Job-order frequency:
Methods and planning time:
Engineering documentation time:
Part name and number:
Type of material and form:
Part dimensions and weight:
Special characteristics:
(Close tolerances, special finishes, high hardness, brittle material, etc.)

Sketch of part

NUMERICAL CONTROL

	Time	Cost extension
Operation		
Program		
Prep. tape		
Setup		
Hold plate		
Plate mat'l	X	
Spec. tools		
Running		
TOTAL		

OPERATIONAL DETAILS

	Operation	Equipment used	Operation time	Cost extension	Move method	Move time	Cost extension	In-process storage space	Storage protection	Special tooling	Tooling cost	Setup time	Cost extension	Inspection time	Cost extension	Total time	Total cost	Normal % scrap
1																		
2																		
3																		
4																		
5																		
	TOTAL																	

on actual operating costs, is $50 per hr and that the N/C machine is rated at $35 per hr. Now the two-shift-per-year differential is only $54,000 (allowing 10% for downtime). The numerically controlled machine pays for itself in two years after a 52% tax—probably much closer to reality.

Incidentally, the pay-back method of evaluating an investment is almost as bad as "general overhead," but we'll go further into that problem later.

Only productivity was involved in the foregoing example and the outcome would be the same whether this factor was increased by N/C or by any other means. In fact, on this basis alone, there are times when savings in direct-labor aren't large enough to justify selection of numerically controlled equipment.

Labor saving not enough

Though very valuable, a straight increase in productivity is not the strongest suit in the numerical-control concept. The real value in numerically controlled equipment is in its ability to readily accept instructions and to quickly and accurately translate them into physical dimensions in the work, all with a minimum of special aids.

In other words, savings in the cost per piece by reductions in layout, tooling costs, setup time, scrap, lead time, and inventory can prove more profitable than increased productivity. If these factors had been weighed into the examples above, the pay-back period might readily have been halved to one year after taxes, or better. A sound cost accounting system would spell out these expenses.

Job analysis, in the absence of an adequate cost picture, can be quite helpful. A detailed job description followed by evaluation of your requirements will give you a composite of equipment characteristics. Then you can estimate the values for each requirement.

If your company's cost records yield no useful data, and you want some ballpark figures to get started, work with what you have. Lack of costs is no excuse.

Select a representative sample of 10 to 15 typical jobs (parts) from normal factory operations. (Don't attempt to study too many jobs simultaneously.) Explain to Accounting what you are trying to prove and, by outlining the procedure, get Accounting to agree that they will accept the figures on the samples. Ask the financial people to tell you what data they want most.

For your initial study, shoot for an overall accuracy of ±20%. Usually this estimating range will show you outstanding opportunities for improvement, if they exist. Then, later, where individual comparisons between N/C and conventional equipment are close these specific data can be refined.

Use standard *time* information from company records, where it is available. Assemble all the historical data available on each job. *Forget the assigned, or "standard," costs* unless they can be reduced, by a true common denominator, into their actual elements. Extending the time to dollars is one of the final analytical steps.

Check the annual volume and normal lot-size for each sample part. Indicate how much of the volume goes into Original Equipment and how much is produced for "Spares." For existing parts, how frequently are orders placed in the shop; how quickly does the last part in a lot become an "account-receivable" by delivery to a customer?

Specify the material used to produce each of the sample parts, and its initial form, such as: casting, forging, sheet, plate, barstock, cold-headed blank, weldment, etc. Indicate the value of the material and any special conditions of use.

Detail the operations to make the parts on existing equipment. Determine the actual machining time required. Use MTM (Methods-Time Measurement) or equivalent data if you have it or can have someone calculate the time for you. For this study your methods and time-study people can be extremely helpful. If you can, discuss the analysis with an industrial engineer. For this purpose time figures offer a much more accurate standard of measurement than dollars of improperly extended "standard" costs.

Engineering time too

Once you have detailed actual machine time by operations, indicate for each operation the estimated setup time and the special tooling required for that operation, including an estimate of the time to engineer and produce the tooling.

Following these figures, for each operation, estimate the "move" or materials-handling time required. Indicate the equipment necessary to move the work—whether tote box, lift truck, conveyor, crane, trunnion, or manual transfer—and the number of people involved in the move. How far must the part be moved? Concern yourself only with in-process materials handling, not with shipping or warehousing, and include a figure for the temporary storage space required at each machine for a typical lot size for each part. Are any special containers or treatments used for storage between operations?

From the information you have gathered so far, guesstimate the methods and planning time necessary to get each part into the manufacturing cycle. (Some of this time is equivalent to the time you have put into this analysis.)

Either as part of the planning time or separately, calculate the engineering - documentation time required for each part. How much time went into drafting, detailing, and dimensioning the drawing; into operation sheets or job instructions? How much time is given to changing drawings or operation sheets?

Now find dollars

With this data itemized, you are in a position to extend the manufacturing time into manufacturing dollars. Unless you have direct machine-hour rates, which would eliminate most of the foregoing work, ignore the general burden and use direct-labor costs for each of the time units you have included. (As general-burden is applied equally to all direct labor, and inasmuch as many of the foregoing items would normally be included in general-burden, leaving it out of both sides of a comparison does more good than harm.)

Of course, if you can include reasonably accurate machine costs at this point, your comparison will be more exact and your further analysis considerably reduced. *It is important to recognize that the data just compiled is purely to determine whether numerical control is suitable for these sample jobs, and to give data for rating profitability. If N/C appears worthwhile, the actual purchase of equipment must be justified in a more formal presentation.* Much of this data will be necessary for justification. Direct-labor rate is not enough.

As the analysis of each sample part is completed from an operational standpoint, the data can be used to prepare the job description discussed earlier. This task is much simpler than the process analysis. It is defining the job characteristics.

On a form similar to that shown, evaluate such things as the skill required to produce the part, the productivity called for, responsibility for product value, and capacity necessary. How large and heavy is the piece to be worked? What tolerances are specified? How many pieces per hour or day are needed? Is the shape complex? How many different tools are needed to complete each sample part? How much money is lost if a system error scraps the piece?

The last question shows how closely numerical control relates to human skills. You are not very likely to assign a drillpress operator to a manually controlled jig-borer to complete a part worth $10,000. In the same sense when you are making a decision between a $5000 control system and a $10,000 or $20,000 control system, it pays to know what the system offers—and how much money is at stake if the control scraps a piece.

Even more specifically, this kind of "responsibility" information helps you decide what auxiliary and preventive devices you require — and how much you will pay for them. This factor affects the selection of programming equipment and procedures as well as the manufacturing equipment.

By evaluating the requirements brought out in the job description, you can determine the class of machine needed to produce the part. From the *AM/MM* numerical Control Selector Tables, you can pick the class of equipment which most closely meets your need.

Having gone this far in comparing people and N/C, ask the builders, or their distributors, of equipment in the class you require to supply a "resume." Give them copies of the process analyses and the job analyses. Discuss your requirements with them. Ask them to propose the best combination of machine-tool, or other equipment, and control system to do the job.

Run a few jobs

For the equipment that seems most suitable, ask to have several of the sample jobs programmed, and a few of them actually produced, *at your expense.* Now you have actual time, and cost, figures for programming, tape preparation (if any), tooling, and setup. From the tape you can get the exact running time. Or you can time the job on the machine. Loading and unloading time is readily calculated, measured, or taken from standards.

With the information from your analyses plus the data for production on actual numerically controlled equipment, you are able to determine several things:

1. Whether numerical control is

suitable for the parts you manufacture.

2. Which parts offer the most savings over conventional methods.

3. Which N/C equipment offers the best combination of capabilities for the installed cost.

4. The characteristics most subject to compromise.

5. The most suitable types of jobs for a specific machine.

6. The most suitable class of machine for a specific part.

Recognize early in your quest that most numerically controlled equipment is more expensive, more complex, and much more sophisticated to operate and maintain than any manufacturing equipment heretofore available. You don't get anything for nothing. The numerically controlled machine is a high-bred racehorse that produces a sizable purse but, to do so consistently, must be kept in condition.

Perhaps you have begun to feel that by following this procedure you spend more time analyzing than you'll save with numerical control. This is not the case at all. These analyses are no more than you would normally do in planning a production job. It is not necessary to completely study every job in the shop.

Serves double purpose

This set of sample jobs serves its first purpose in helping you determine whether numerical control will pay, and as an aid to selection. Then, if you acquire N/C equipment, it provides a simple basis for determining which jobs, by comparison, are best worked on the equipment. However, if it hasn't been done in the past, keeping records of future operating data is urged. And a few studies, from time to time, in other areas can show profitable results.

The problems before acquisition of N/C equipment are entirely different, when it comes to selection, from the problems after acquisition. The first machine is the biggest hurdle. Almost invariably, people using N/C tell us that its exceptional capability can readily turn the equipment into a bottleneck. So much work is scheduled for the N/C equipment that orders pile up to wait their turn while conventional machines stand idle. Jobs must be assigned to provide the most profitable utilization of the equipment.

Quick estimates for cost comparisons of operations performed on N/C multi-operation machines, or "machining centers," and on N/C turret drillpresses, versus conventional milling machines and sensitive drillpresses can be made from some simple graphs. Actually, any operations can be graphed. These graphs, based on the relationship between cost and the number of operations, cover two basic phases of costs—pre-running costs and running cost.

Pre-running cost is the fixed cost necessary before any part can be run on a machine. This cost does not vary with the number of parts in a lot and includes such constants as:

1. For N/C multi-operation machine or turret drillpress
   a. Program part and locating plate
   b. Prepare tape (for part and locating plate)
   c. Set up
   d. Material cost for locating plate
   e. Special tools if necessary

2. For conventional millers and sensitive drillpresses
   a. Fixtures
   b. Set up
   c. Miscellaneous functions

Running cost is the per-part direct-labor cost. It also can be applied as machine-hour rate where this rate is available for both types of equipment.

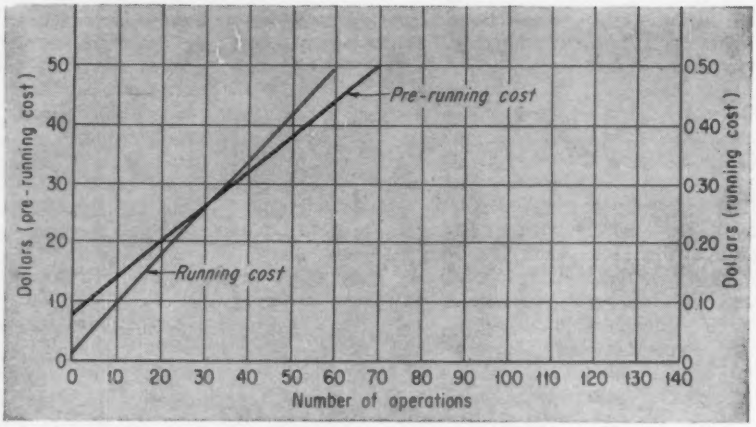
Total cost per part is computed as:

$$\frac{\text{Pre-running cost}}{\text{Estimated annual production}} + \text{Running cost/part} = \text{Total cost/part}$$

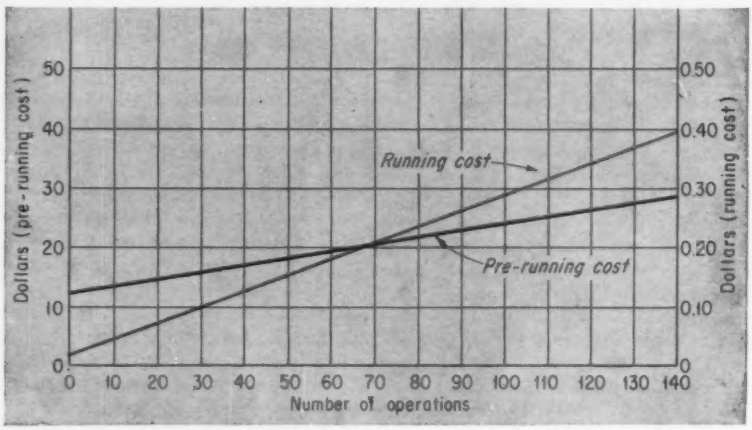
For these graphs, an operation is considered as any motion which requires a feed rate. All other motions are at rapid traverse or related speeds. For simplicity, they are not counted in the figures on the graphs.

Graphs for each type of equipment were prepared from the process analysis data (cost per piece and

Quick cost comparison—N/C vs conventional

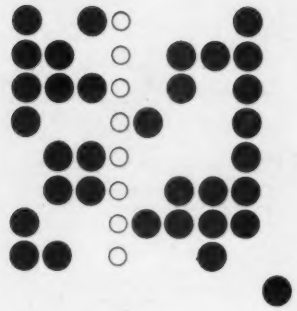

Pre-running cost
Running cost
Dollars (pre-running cost)
Dollars (running cost)
Number of operations
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
0 10 20 30 40 50
0 0.10 0.20 0.30 0.40 0.50

Cost per piece of pre-running and running costs on a sensitive drillpress is plotted as the total number of operations, for comparison with . . .


Running cost
Pre-running cost
Dollars (pre-running cost)
Dollars (running cost)
Number of operations
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
0 10 20 30 40 50
0 0.10 0.20 0.30 0.40 0.50

A numerically controlled turret drillpress. The value of N/C increases with the number of operations. Any machine tools, or parts, can be used.

This section continued on page 113



HOW TO

PROVE THE PROFIT

IN

NUMERICAL CONTROL

Numerical control selector guide

Compiled by James Peacock, assistant editor

Practically all numerically controlled machine tools and control systems made in the US, as well as some others, are listed in this guide. A very few companies, however, did not respond to AM/MM's requests for information, and there may be a few inadvertent omissions.

This tabulation gives price and characteristics of each listed piece of equipment, as reported by the manufacturer. Slight changes or abbreviations have been made only to fit the strict space limitations. However, in using this as a guide for machine or system selection, the reader is urged to verify all data with the equipment manufacturer.

Accuracy and repeatability, as well as system resolution, have been arbitrarily listed as plus or minus. A "contouring" degree of control for any machine presupposes positioning and sequencing.

Machine listings begin on the bottom half of this page. Data for control systems starts on page 105.

Company name	Air Reduction Sales Co	American SIP Corp	American SIP Corp	American SIP Corp
Address	150 E 42nd St New York, NY	100 E 42nd St New York 17, NY	100 E 42nd St New York 17, NY	100 E 42nd St New York 17, NY
Tradename or model number	Tape-O-Graph	Hydroptic 6A	Hydroptic 7A	MP-3K CN
Type or function	Flame cutting machine	Jigborer, milling machine	Jigborer, milling machine	Jigborer
Capacity	2 plates (10x40') 6" thick	43¼ x 33-in. table	61¾ x 40½-in. table	20½ x 15-in. table
Longest axis of motion	40 ft	36¾ in.	51 in.	18 in.
Spindle horsepower	None	8 hp	8 hp	1 hp
Number of controlled spindles	None	One	One	One
Minimum decimal input	0.001 in.	0.0001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.001 in.	0.0001 in.	0.0001 in.	0.0001 in.
Normal operating accuracy	±0.015 in.	±0.000,075 in.	±0.0001 in.	±0.000,075 in.
Repeatability	±0.015 in.	±0.000,04 in.	±0.000,04 in.	±0.000,04 in.
Controlled motions	X and Y	Table and head, feed; vertical spindle, speed and feed	Table and head, feed; spindle speed, feed; rotary table	Table and head
Degree of control	Sequence, contour	Sequencing, positioning	Sequencing, positioning	Positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	DC motors	Mechanical and hydraulic	Mechanical and hydraulic	Mechanical and hydraulic
Speed range	2 to 33 ipm; 1 ipm steps	40 to 2000 rpm; 18 steps	40 to 2000 rpm; 18 steps	75 to 2000 rpm; 8 steps
Feed range	———	2 to 100 ipm; 6 steps	2 to 100 ipm; 6 steps	0.0008 to 0.007 ipr; 6 steps
Control system	GE Mark Century	SIP CN-4	SIP CN-4	Sperry Gyroscope
Manual operation?	Yes, manual dialing	Yes, with manual controls	Yes, with manual controls	Yes, with manual controls
Auxiliary functions	Preheat fuel gas; control ignition, cutting oxygen	Slow and rapid spindle return, index aux rotary table	Slow and rapid quill return	———
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	No	Yes	Yes	Yes
Safe ambient temperature	0 to 110 F	50 to 115 F	50 to 115 F	55 to 110 F
Special tool preparation	None	None	None	None
Zero offset range	Entire cutting area	±2 in.	±2 in.	18 in.
Zero shifting method	No fixed zero	Mechanical	Mechanical	Mechanical
Service provisions	Warranty, GE and Airco	Warranty, American SIP	Warranty, American SIP	Warranty, American SIP
Training offered	Not established	Yes, at Geneva, Switz	Yes, at Geneva, Switz	No
Normal time to learn	———	1 to 3 months	1 to 3 months	———
Average installed cost	$150,000	$86,400	$113,500	$41,000
Typical job-lot size	1 to 100 parts	1 to 100 (or more)	1 to 100 (or more)	1 to 100 (or more)
Productivity over conventional	No machines sold	20 to 30%	20 to 30%	Too early
Designed for N/C?	Specifically	No, converted standard	No, converted standard	No, converted standard
Typical parts produced	Mechanical components (cut from ¼ to 6" steel plate) for machining or welding	Parts for machine tool gearboxes and jet motors	Parts for machine tool and other gear boxes and for jet motors	All parts normally machined on this type jigborer
Additional information	Represents first use of numerical control on flame cutting machine in US	This machine with DIR-4 is similar to a N/C machine. Average reported downtime: 20 to 30% (measured by users)		

Company name **Address**	The American Tool Works Co Pearl & Eggleston Aves Cincinnati 2, Ohio	The American Tool Works Co Pearl & Eggleston Aves Cincinnati 2, Ohio	The American Tool Works Co Pearl & Eggleston Aves Cincinnati 2, Ohio	The American Tool Works Co Pearl & Eggleston Aves Cincinnati 2, Ohio
Tradename or model number	819-32 Openside Boring and Drilling Machine	Model AA Turretdex Boring and Drilling Machine	511-12 Semi-Automatic Boring and Drilling Machine	American Continuous Path Tape Controlled Lathe
Type or function	Boring, drilling large work	Automatic turret-type work	Precision boring, drilling	Contour lathe
Capacity	6 x 100 ft	30 x 30-in. working area	30 x 30-in. working area	6 sizes, from 2010 to 4732
Longest axis of motion	100 ft	30 in.	30 in.	11 ft
Spindle horsepower	30 hp	5 hp	7½ hp	Up to 60 hp
Number of controlled spindles	One	6 or 8	One	One
Minimum decimal input	0.001 in.	0.0001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.001 in.	0.0001 in.	0.0001 in.	0.0002 in.
Normal operating accuracy	±0.002 in.	±0.001 in.	±0.0005 in.	±0.0005 in.
Repeatability	±0.001 in.	±0.0005 in.	±0.00025 in.	±0.00025 in.
Controlled motions	X and Y, and spindle autocycling	Table, X and Y axes; spindles, Z axis	Table X and Y axes, spindle (cycling)	Carriage and slide
Degree of control	Positioning	Positioning	Positioning	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	No
Type of drive	Precision rack	Hydraulic cylinders	Hydraulic cylinders	Recirculating ball screws
Speed range	20 to 1600 rpm; incr	70 to 3000 rpm; incr	45 to 3000 rpm; incr	5 to 1800 rpm; incr
Feed range	0.003 to 0.125 ipr; incr	1 to 65 ipm; inf adj	0.001 to 0.025 ipr, incr	0.01 to 100 ipm; inf adj
Control system	GE Mark II	Sperry Gyroscope	Sperry Gyroscope	GE Mark Century
Manual operation?	Yes, manual input	Yes, manual input data	Yes, manual input data	Yes, manual input media
Auxiliary functions	Coolant control, speed, feed	Coolant on/off, chip cleaner (air blast)	Coolant on/off, spindle autocycling	Coolant control, turret indexing, speeds, feeds
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	110 F	110 F	110 F	110 F
Special tool preparation	None	None	None	Yes
Zero offset range	Full	±0.200 in.	±0.200 in.	Full
Zero shifting method	Declutch selsyns	Manual	Manual	Automatic selsyn
Service provisions	Warranty, GE	Warranty, ATW and Sperry	Warranty, ATW and Sperry	Warranty, GE
Training offered	Yes, at Waynesboro	Yes, at customer's plant	Yes, by Sperry	Yes, at Waynesboro
Normal time to learn	As required	As required	As required	As required
Average installed cost	$90,000 to $110,000	$60,000 (approx)	$47,750 (approx)	$100,000 to $125,000
Typical job-lot size	2 to 15 pieces	From 10 up	3 to 10 pieces	2 to 15 parts
Productivity over conventional	30 to 45%	30 to 45%	30 to 45%	40 to 55%
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Side frames, safe doors, locomotive truck frames, shovel bases, steel plates	Valve bodies, gear case covers, hydraulic manifolds, other std boring and drilling	Valve bodies, gear case covers, hydraulic manifolds, prototype parts	Gear blanks, shafts, rolls, any round or contoured parts, prototype parts
Additional information	Flexibility of operation with capability of performing boring and drilling with considerably less "first cost" investment		Designed to fill vacuum between horizontal boring machine and jigboring work	Designed and developed for small production runs as a fully automatic machine needing minimum operator attention. Gives superior finish, optimum machine tool utilization, optimum tool life

Company name **Address**	Avey Div, M&M Mach Co 25 E 3rd St Covington, Ky	Avey Div, M&M Mach Co 25 E 3rd St Covington, Ky	Avey Div, M&M Mach Co 25 E 3rd St Covington, Ky	Baldwin-Lima-Hamilton Corp Industrial Equipment Div Philadelphia 42, Pa
Tradename or model number	No. 4 BMA-6 with 25 x 35-in. positioning table	No. 250 Turret-Dex with Positioning movement	No. 250 Turret-Dex with 30" dia rotary, 12" col slide	Bend-O-Matic Models 100 and 200
Type or function	Single spindle drill	Turret drill	Turret drill	Tube bending
Capacity	2-in. CI, 1½-in. steel	15x20 in.; 25x35 in.; 12x100"	———	Up to 2-in. OD tubing
Longest axis of motion	35 in.	20 in.; 35 in.; 99.999 in.	12 in. column	36 in.
Spindle horsepower	5 hp	5 hp	5 hp	1/3 hp (tube bender)
Number of controlled spindles	One	6 or 8	6 or 8	None
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.1 in.
Smallest motion increment	0.002 in.	0.002 in.	0.002 in.	0.36 deg
Normal operating accuracy	±0.002 in.	±0.002 in.	±0.002 in.	±1.8 deg
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±1.8 deg
Controlled motions	Two axes of table motion	Two axes of table, std; 3rd axis of head feed, optional	Rotary table and 12 in. column slide	Bending, linear feed, polar rotation
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Depends on control used	Depends on control used	Depends on control used	Yes
Type of drive	DC motors to lead screws	DC motors to lead screws	DC motor	Thymatrol motor & Rotac hyd
Speed range	110 to 1800 rpm; incr	3 ranges, 70-3000 rpm; incr	3 ranges, 70-3000 rpm; incr	———
Feed range	0.004 to 0.020 ipr; incr	0 to 70 ipm; inf adj	0 to 70 ipm; inf adj	600 ipm; inf adj
Control system	Any std positioning system	Any std positioning system	Any std positioning system	GE, modified Mark III
Manual operation?	Yes, dial control	Yes, dial control	Yes, dialing	Yes, selector switch
Auxiliary functions	Cycle, coolant, air blast, tool change light	Turret selection, coolant, air blast, speeds, feeds	Turret selection, coolant, air blast, speeds, feeds	Clamping, saw cutoff
Automatic tool changer	No	Standard	Standard	Optional mandrel control
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	Std tapes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	120 F	120 F	100 to 105 F
Special tool preparation	None	None	None	No, changing dies
Zero offset range	Depends on control	Depends on control	Depends on control	Setup only
Zero shifting method	———	———	———	Manual
Service provisions	Warranty, Avey & control mfr	Warranty, Avey & control mfr	Warranty, Avey & control mfr	Warranty, B-L-H & GE
Training offered	Yes, by Avey & control mfr	Yes, by Avey and control mfr	Yes, by Avey & Control mfr	Yes, customer's choice
Normal time to learn	2 days to one week	2 days to one week	2 days to one week	2 to 3 weeks
Average installed cost	$36,000	$40-50,000; 50-60,000; 75,000	$50,000 to $60,000	$75,000 to $90,000
Typical job-lot size	1 to 50 parts	1 to 50 parts	1 to 50 parts	One or more
Productivity over conventional	———	Varies	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Tube sheets	Cylinder heads, pump bodies, misc machine components	Flywheels	Tail & exhaust pipes for autos, precision aircraft tubes, furniture, etc
Additional information				

N/C Selector Guide—Machines

Company name	Barber-Colman Co	Barnes Drill Co	Barnes Drill Co	Barnes Drill Co
Address	1300 Rock St Rockford, Ill	814 Chestnut St Rockford, Ill	814 Chestnut St Rockford, Ill	814 Chestnut St Rockford, Ill
Tradename or model number	Tape-R-Guide Lathe	Special	Special	Special
Type or function	Facing, turning, boring	Drilling machines	Boring machine	Drilling and tapping
Capacity	16-in. dia over ways	36-in. dia parts 40 in. high	Max 50-in. dia, 40-in. height	50-in. dia x 72 in. high
Longest axis of motion	30 in.	48 in.	50 in.	72 in.
Spindle horsepower	15 hp	5 hp	5 hp	2 hp
Number of controlled spindles	One	One	Four	Two
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.002 in.	±0.003 in.	±0.003 in.	±0.003 in.
Repeatability	±0.0005 in.	±0.0002 in.	±0.0002 in.	±0.0002 in.
Controlled motions	Cross feed, longitudinal feed, and spindle	Vertical and rotary motion	Vertical and rotary	Vertical, rotary, in and out, ±15° to head
Degree of control	Contouring	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	8-channel punched tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	No	Yes	Yes	Yes
Type of drive	Var speed DC motors	Selsyn	Selsyn	Selsyn
Speed range	100 to 1200 rpm; inf adj	4 to 1 thru PO gears; incr	4 to 1; incr	4 to 1 thru PO gears; incr
Feed range	0.001 to 0.031 ipr; incr	0 to 60 ipm; inf adj	0 to 120 ipm; inf adj	0 to 120 ipm; inf adj
Control system	Barber-Colman, Tape-R-Guide	GE, modified Mark II	GE, modified Mark II	GE, modified Mark IV
Manual operation?	No	Yes, selective	Yes, selective	Yes, selective
Auxiliary functions	Rapid traverse, spindle stop, coolant on/off, air chucking	Tool selection, coolant on/off, speed, feed, depth	Tool selection, coolant on/off, speed, feed	Tool selection, coolant on/off, positive depth control
Automatic tool changer	No	Optional	Optional	Optional
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	Yes	Yes	Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	104 F	Normal	Normal	Normal
Special tool preparation	Yes	Yes	Yes	Yes
Zero offset range	Not required	Not offered	Not offered	Not offered
Zero shifting method	———	———	———	———
Service provisions	Warranty, Barber-Colman	Warranty, Barnesdril	Warranty, Barnesdril	Warranty, by Barnesdril
Training offered	Yes, at Rockford	Yes, at customer's plant	Yes, at customer's plant	Yes, at customer's plant
Normal time to learn	2 weeks	2 weeks	2 weeks	2 weeks
Average installed cost	$43,000	$125,000	$165,000	$200,000
Typical job-lot size	1 to 50 pieces	All within mach capacity	All within mach capacity	Classified
Productivity over conventional	———	13 to 1	74% (in setup time)	Classified
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Any part needing drilling, boring, reaming, step and/or taper turning	Jet engine compressor casings	Jet engine compressor casings	
Additional information	Has automatic load control device to allow programming beyond 100% machine capacity. This limits feed rate to 100% capacity of spindle drive, assuring max use of machine while roughing			

Company name	Beatty Machine & Mfg Co	Brown & Sharpe Mfg Co	Brown & Sharpe Mfg Co	The Bullard Co
Address	940 150th St Hammond, Ind	235 Promenade St Providence, RI	235 Promenade St Providence 1, RI	286 Canfield Ave Bridgeport 9, Conn
Tradename or model number	Beatty Spacing Table	Numericam	Model B	Dynamill
Type or function	Spacing for punching	N/C cam milling machine	Turret drilling machine	Table-type horizontal borers
Capacity	30-in. beams, 50 ft long	10-in. circle, 3½ in. deep	1-in. NC tap, mild steel	3, 4, & 5-in. spindle dia
Longest axis of motion	50 ft	10 in.	15 to 90 in.	100 in.
Spindle horsepower	———	5 hp	5 hp	15 to 40 hp
Number of controlled spindles	———	One	Six	One
Minimum decimal input	0.062 in.	0.0001 in.; 0.0001 of circle	0.001 in.	0.00025 in.
Smallest motion increment	0.062 in.	0.0001 in.; 0.0001 of circle	0.001 in.	0.005 in.
Normal operating accuracy	±1/32 in.	±0.0002 in.	± 0.015 in.	±0.001" 1st ft, ±.0001"/ft
Repeatability	±1/32 in.	±0.0002 in.	±0.0005 in.	±0.0005 in.
Controlled motions	Longitudinal	Long position of table, angular position of spiral head	Longitudinal, transverse and vertical	Head, table, saddle, and rotary table
Degree of control	Sequencing and positioning	Contouring (point-to-point)	Sequencing and positioning	Sequencing and positioning
Type of data-input media	Punched tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Amplidyne	Thymatrol	Variable speed motors	Constant hp motor
Speed range	100 fpm	40 to 1530 rpm; 18 steps	3 ranges, 60-3000 rpm; inf adj	Various; incr
Feed range	———	¼ to 60 ipm; inf adj	.0025-.021, .0012-.011; inf adj	Various; inf adj
Control system	GE, Mark I NPC	GE, Mark II	Varies	User's choice
Manual operation?	Yes, dial setting	Yes, handwheels, pushbuttons	Yes, turn off auto features	Yes, NPC and manual controls
Auxiliary functions	Punch gage control	Up to 8 are available	10 auxiliary function circuits	All machine functions
Automatic tool changer	———	No	No	Optional
Normal programming procedure	Manual	Computer	Manual	Manual
Are sub-routines available?	———	Yes	———	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	———	104 F	68 to 104 F	100 F
Special tool preparation	Yes	None	None	Yes and no
Zero offset range	±0.200 in.	±0.020 or infinite	±0.020" or full table range	Infinite
Zero shifting method	Dial	Electrical, friction clutches	Elec or elec/mech	Manual
Service provisions	Warranty, GE	Warranty, Brown & Sharpe	Warranty, Brown & Sharpe	Warranty, Bullard
Training offered	Yes, by General Electric	Yes, at B&S or customer's	Yes, at customer's plant	Yes, by Bullard & control mfr
Normal time to learn	One week	4 to 6 weeks	2 to 3 days	4 to 5 days
Average installed cost	$40,000	$60,000	$36,000 to 70,000	———
Typical job-lot size	Single pieces	1 to 10 pieces	One up	———
Productivity over conventional	———	Up to 90%	2 to 1 up to 5 to 1	3 to 1 (conservatively)
Designed for N/C?	Specifically	Specifically	Some sizes	Specifically
Typical parts produced	Normal structural punching of beams, channels, angles, and plates		Small pieces with holes from 0.040 to 0.060 in. up to 1 to 8-in. tapped holes	Components for aircraft engines, missile systems, electrical manufacturers
Additional information	This is an experimental table installed in Beatty plant	Program tapes and detail instructions for IBM 610 are available to purchasers. Machine can be fitted with GE Mark III so that cutter feed depth can also be programmed from tape	Self-aligning turret spindles give tool alignment regardless of indexing accuracy. CEDA/SEAT control assures depths within 0.002 in. Head adjusts vertically to compensate for job size	

Company name	The Bullard Co	Burgmaster Corp	Burgmaster Corp	Burgmaster Corp
Address	286 Canfield Ave Bridgeport 9, Conn	15001 S Figueroa St Gardena, Calif	15001 S Figueroa St Gardena, Calif	15001 S Figueroa St Gardena, Calif
Tradename or model number	Dynatrol	2 BHT	2 BHTL and 2 BHTXL	3 BHT
Type or function	Vertical turret lathe	Turret drill	Turret drill	Turret drill
Capacity	26 to 144-in. table dia	¾-in. drill in steel	¾-in. drill in steel	1½-in. drill in steel
Longest axis of motion	144 in.	18 in.	26 in., 30 in.	30 in.
Spindle horsepower	30 to 125 hp	2 hp	2 or 3 hp	10 hp
Number of controlled spindles	One	Six	6	8
Minimum decimal input	0.00025 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.005 in.	0.002 in.	0.002 in.	0.002 in.
Normal operating accuracy	±0.001 in. (at tool point)	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±0.0005 in.
Controlled motions	Vertical and horizontal axes of each head	X and Y with Z optional	X and Y with Z optional	X and Y with Z optional
Degree of control	Contouring	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	No	Yes
Type of drive	Control hp motor	Electric	Electric	Electric
Speed range	Various; incr and inf adj	90 to 4500 rpm; incr	90 to 4500 rpm; incr	20 to 2400 rpm; incr
Feed range	Various; incr and inf adj	¼ to 50 ipm; inf adj	¼ to 50 ipm; inf adj	¼ to 50 ipm; inf adj
Control system	User's choice	GE, Mark II, III, 103 P	Hughes, NC 200, Rheem	Warner & Swasey
Manual operation?	Yes, thru N/C and normally	Yes, dial buttons	Yes, dial buttons	Yes, dial buttons
Auxiliary functions	All machine functions	Coolant on/off, programmed milling, speeds, feeds, clamp	Coolant on/off, programmed milling, speeds, feeds, clamp	Coolant on/off, programmed milling, speeds, feeds, clamp
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	Yes			
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	100 F	110 F	110 F	110 F
Special tool preparation	Yes and no	Desirable on 3rd axis	Desirable on 3rd axis	Desirable on 3rd axis
Zero offset range	Infinite	10 x 18 in. (at extra cost)	Full, 20x30" (extra cost)	20 x 30 in.
Zero shifting method	Manual	Electric	Electric	
Service provisions	Warranty, Bullard	Warranty, Burgmaster	Warranty, Burgmaster	Warranty, Burgmaster
Training offered	Yes, by Bullard & control mfr	Yes, at customer's plant	Yes, at customer's plant	Yes, at customer's plant
Normal time to learn	2 to 3 weeks	One week	One week	One week
Average installed cost		$35,000	$40,000, $45,000	$55,000
Typical job-lot size		1 to 100	1 to 100	1 to 100
Productivity over conventional	3 to 1 (conservatively)	2 or 3 to 1	2 or 3 to 1	2 or 3 to 1
Designed for N/C?	Specifically	No, adapted later	No, adapted	No, adapted
Typical parts produced	Components for aircraft engines, missile systems, electrical manufacturers	Hydraulic valves, seat covers, circuit boards, tube sheets		
Additional information		Can do more than one operation, including milling. Tremendously cuts down lead time, handling time, manufacturing time, and gives great savings in tooling costs		

Company name	Burgmaster Corp	Burgmaster Corp	Burgmaster Corp	Burgmaster Corp
Address	15001 S Figueroa St Gardena, Calif	15001 S Figueroa St Gardena, Calif	15001 S Figueroa St Gardena, Calif	15001 S Figueroa St Gardena, Calif
Tradename or model number	3 BHT-B	3 BHTL	25 AHT	25 AHTL and 25 AHTXL
Type or function	Turret drill	Turret drill	Turret drill	Turret Drill
Capacity	1½ in. drill in steel	1½-in. drill in steel	1¼-in. drill in steel	1¼-in. drill in steel
Longest axis of motion	60 in.	45 in.	26 in.	30 in., 45 in.
Spindle horsepower	15 hp	10 or 15 hp	7½ hp	7½ hp
Number of controlled spindles	8	8	6	6
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.002 in.	0.002 in.	0.002 in.	0.002 in.
Normal operating accuracy	±0.002 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±0.0005 in.
Controlled motions	X and Y with Z optional	X and Y with Z optional	X and Y with Z optional	X and Y with Z optional
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive		Electric	Electric	Hydraulic
Speed range	20 to 2400 rpm; incr	20 to 2400 rpm; incr	100 to 3000 rpm; incr	100 to 3000 rpm; incr
Feed range	¼ to 50 ipm; inf adj	¼ to 50 ipm; inf adj	¼ to 50 ipm; inf adj	¼ to 50 ipm; inf adj
Control system	GE or others	Bendix Dynapoint	Westinghouse, Prodac	Moog Servocontrols, Sperry
Manual operation?	Yes, dial buttons	Yes, dial buttons	Yes, dial buttons	Yes, dial buttons
Auxiliary functions	Coolant on/off, programmed milling, speeds, feeds, clamp	Coolant on/off, programmed milling, speeds, feeds, clamp	Coolant on/off, programmed milling, speeds, feeds, clamp	Coolant on/off, programmed milling, speeds, feeds, clamp
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?				
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	110 F	110 F	110 F	110 F
Special tool preparation	Desirable on 3rd axis	Desirable on 3rd axis	Desirable on 3rd axis	Desirable on 3rd axis
Zero offset range	48 x 60 in.	30 x 45 in.	No	No, 30x45 in. (extra cost)
Zero shifting method	Electric			Electric
Service provisions	Warranty, Burgmaster	Warranty, Burgmaster	Warranty, Burgmaster	Warranty, Burgmaster
Training offered	Yes, at customer's plant	Yes, at customer's plant	Yes, at customer's plant	Yes, at customer's plant
Normal time to learn	One week	One week	One week	One week
Average installed cost	$95,000	$70,000	$47,000	$52,000, $60,000
Typical job-lot size	1 to 100	1 to 100	1 to 100	1 to 100
Productivity over conventional	2 or 3 to 1	2 or 3 to 1	2 or 3 to 1	2 or 3 to 1
Designed for N/C?	Specifically	No, adapted	No, adapted	No, adapted
Typical parts produced				
Additional information				

Company name	Cincinnati Lathe and Tool Co	Cincinnati Lathe and Tool Co	Cincinnati Lathe and Tool Co	Cincinnati Gilbert M T Co
Address	Cincinnati 9 Ohio	Cincinnati 9 Ohio	Cincinnati 9 Ohio	3366 Beekman St Cincinnati 23, Ohio
Tradename or model number	Cintimatic 1020	Cintimatic Turret Drill	Cintimatic Lathe	Cincinnati Gilbert Horizontal Floor-Type Boring Mill
Type or function	Drilling and tapping	Drill, ream, bore, tap, mill	Turning	Horizontal boring mill
Capacity	1-in. mild steel	1¼-in. mild steel	22¼" over bed, 12", slide	36 x 48 x 22 in. (min)
Longest axis of motion	20 in.	30 in.	48, 72, or 96" centers	Infinite
Spindle horsepower	3 hp	5 hp	15 hp	15 to 30 hp
Number of controlled spindles	One	Six	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.002 in.	±0.001 in.	±0.0015 in.	±0.0005 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±0.0002 in.
Controlled motions	X and Y, Z optional	X, Y, and Z axes	X and Y	X, Y, and Z
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Seq, posit, contour (opt)
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic cylinders	Hyd motors, ballscrews	Hydraulic motors	AC clutch or DC servo
Speed range	60 to 1850 rpm; inf adj	70 to 2120 rpm; incr	50 to 2000 rpm; incr	10-1000, 15-1500 rpm; incr
Feed range	0.002-0.015 ipr or 0-25 ipm	½ to 49½ ipm; incr	.001-10 (cross), .200-20 (long)	0.003 to 0.250 ipm; incr
Control system	Cincinnati Acramatic	Cincinnati, Acramatic	Cincinnati, Acramatic	GE Mark series, Mark Century
Manual operation?	Yes, dial	Yes, dial input	Yes, dial input	Yes, full pendant controls
Auxiliary functions	Feed cycle and depth	Turret, speeds, feed, machining cycles, coolant, op no.	Tool selection, spindle speed, coolant, feed	Spindle depth, speeds, feed, clamp, coolant, tool change
Automatic tool changer	No	No	Standard	Optional
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	125 F	125 F	125 F	120 F
Special tool preparation	Yes	None	Yes	In some cases
Zero offset range	±0.050	Full range	Full range	Full range
Zero shifting method	Dial	Dial	Dial	Electric or clutch
Service provisions	Warranty, CL&T	Warranty, CL&T	Warranty, CL&T	Warranty, Gilbert & GE
Training offered	Yes, in Cincinnati	Yes, in Cincinnati	Yes, in Cincinnati	Yes, at Gilbert or user's
Normal time to learn	———	———	———	One to two weeks
Average installed cost	$14,500	$46,500	$48,500	$70,000 to $150,000
Typical job-lot size	1 to 100	1 to 100	1 to 100	One to ten
Productivity over conventional	———	———	———	Up to 5 to 1
Designed for N/C?	Partially	Specifically	Specifically	Specifically
Typical parts produced		———	Stepped shafts, faced and bored workpieces, other multi-diameter shapes	Diesel engine blocks, motor frames, jet engine and machine tool parts, gear cases
Additional information		All machine functions controlled by tape. Hole depth is programmed directly in terms of depth from work surface. Tool length need not be preset or controlled	Has two, 4-way tool stations, tools may be selected at random. Each station may be independently zero shifted. Work diameter directly programmed. Operation completely automatic	Design eliminates wear, wedging pressures, maintains new-machine alignments a long time. Translating screws, at center of narrow guides, translate motion on ctr of gravity of element

Company name	Cincinnati Gilbert M T Co	Cincinnati Milling Mach Co	Cincinnati Milling Mach Co	Cincinnati Milling Mach Co
Address	3366 Beekman St Cincinnati 23, Ohio	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio
Tradename or model number	Cincinnati Gilbert Horizontal Table-Type Boring Mill	N/C Toolmaster Milling Machine	36 x 48 Bridge-type Profile Milling Machine	N/C Verci-Power Milling Machine
Type or function	Horizontal boring mill	Gen purpose milling	N/C profiling	General purpose milling
Capacity	36x60 to 60x120" tables	10 x 22 in.	24, 36, 48, 60-in. tables	34-60", 18", 22-24"
Longest axis of motion	Up to 120 in.	22 in.	4 to 16 ft	34 to 60 in.
Spindle horsepower	15 to 30 hp	2 hp	20 or 30 hp	20 to 50 hp
Number of controlled spindles	One	One	One	1 (plus opt drill head)
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	———	0.001 in.	———
Normal operating accuracy	±0.0005 in.	———	±0.002 in.	———
Repeatability	±0.0002 in.	———	±0.0005 in.	———
Controlled motions	X, Y, Z, and C radial motion	Longitudinal and transverse	Longitudinal, cross, vertical, carrier tilt (optional 4th axis)	Longitudinal, transverse, vertical
Degree of control	Seq, posit, contour (opt)	Sequencing and positioning	Contouring	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape or punched cards	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	AC clutch or DC servo	Hydraulic motor & ballscrews	Screw & rack, twin-pinion	Rack & pinion; ballscrew
Speed range	10-1000, 15-1500 rpm; incr	85 to 3800 rpm; inf adj	30-3000 or 20-3600 rpm; incr	14-1400 or 16-1600 rpm; incr
Feed range	0.003 to 0.250 ipm; incr	1 to 15 ipm; inf adj	¼ to 100 ipm; inf adj	¾ to 75 ipm; incr
Control system	GE Mark series, Mark Century	Cimtrol Div, Acramatic	Cimtrol Div, Acramatic	Cimtrol Div, Acramatic
Manual operation?	Yes, full pendant controls	Yes, conventional handwheels	Yes, from console	Yes, handwheels on panel
Auxiliary functions	Spindle depth, speeds, feeds, clamp, coolant, tool change	6-posit drum stop for spindle, spindle on/off, coolant	12 auxiliary functions provided	Spindle on/off, speed change, coolant on/off
Automatic tool changer	Optional	No	Optional	Optional, with drill head unit
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	Yes		Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	———	60 to 110 F	———
Special tool preparation	In some cases	Yes	None	Yes
Zero offset range	Full range	Full range	Full range	9.999" (contour); full (posit)
Zero shifting method	Electric or clutch	Handwheels	Handwheels	Decade switches; handwheels
Service provisions	Warranty, Gilbert & GE	Warranty, CMMCo	Warranty, CMMCo	Warranty, CMMCo
Training offered	Yes, at Gilbert or user's	Yes	Yes, in Cincinnati	Yes
Normal time to learn	One to two weeks	———	3 weeks	———
Average installed cost	$70,000 to $150,000	———	———	———
Typical job-lot size	One to ten	Varies with use	———	Varies with use
Productivity over conventional	Up to 5 to 1	———	———	———
Designed for N/C?	Specifically	Adapted	Specifically	Specifically
Typical parts produced	Diesel engine blocks, motor frames, jet engine and machine tool parts, gear cases		Aircraft & automotive parts or tools; airframes, templets, dies, gear housings	Any parts that fall within machine's range
Additional information	See floor type machine. Also can be fitted with revolving rotary tables		All movements on recirculating roller bearings (antifriction); remote control spindle speed change; hand programming feature; indicated readout in 0.001 incr; parabolic interpolation	

Company name	Cincinnati Milling Mach Co	Cincinnati Milling Mach Co	Cincinnati Milling Mach Co	Cincinnati Milling Mach Co
Address	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio
Tradename or model number	N/C 48 x 168-in. Traveling Column Hydrotel Mill	N/C 30-in. Vertical Hydro-Tel Milling Machine	5-Axis Numerically Controlled Profile Milling Machine	N/C 16-in. Vertical Hydro-Tel Milling Machine
Type or function	Profile and contour milling	Profile and contour milling	Machine airframe parts	Profiling and contouring
Capacity	48 x 168 in.	30 x 52 to 120 x 14 in.	4 x 14 ft	16 x 30 x 10 in.
Longest axis of motion	168 in.	52 to 120 in.	14 ft	30 in.
Spindle horsepower	10 or 20 hp	20 hp	30 hp	5 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.0002 in.	0.001 in.
Smallest motion increment	0.001 in.	———	0.0002 in.	———
Normal operating accuracy	±0.005 in.	———	±0.005 in.	———
Repeatability	±0.0025 in.	———	±0.0025 in.	———
Controlled motions	Longitudinal, transverse, and depth	Longitudinal, transverse, and vertical	Table, carrier (vertical & depth), twist (2 movements)	Longitudinal, transverse, and vertical
Degree of control	Contouring	Contouring	Contouring	Contouring
Type of data-input media	Punched card	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Rack & pinion and ballscrew	Hydraulic motors & ballscrews	Rack & pinion and ballscrew	Hyd motors & ballscrews
Speed range	22½ to 1800 rpm; incr	16 to 1600 rpm; incr	20 to 3600 rpm; inf adj	30 to 2000 rpm; incr
Feed range	0 to 25 ipm; inf adj	¼ to 25 ipm; inf adj	0 to 200 ipm; incr	1/4 to 25 ipm; inf adj
Control system	Cimtrol Div, Acramatic	Cimtrol Div, Acramatic	Bendix Dynapath 20, others	Cimtrol Div, Acramatic
Manual operation?	Yes, handwheels, jog buttons	Yes, handwheels on panel	Yes, jog button	Yes, handwheels ion panel
Auxiliary functions	12 auxiliary functions available	Spindle on/off, coolant on/off, position readout	8 are available	Spindle on/off, coolant on/off, position readout
Automatic tool changer	No	No	No (optional)	No
Normal programming procedure	Computer	Manual	Computer	Manual
Are sub-routines available?	Yes	Yes	Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	———	———	———	———
Special tool preparation	None	Yes	No	Yes
Zero offset range	Full range	9.999 in.	Full range	9.999 in.
Zero shifting method	Switch	Decade switch	Switch	Decade switches
Service provisions	Warranty, CMMCo	Warranty, CMMCo	Warranty, Bendix	Warranty, CMMCo
Training offered	Yes, in Cincinnati	Yes	Yes, in Detroit	Yes
Normal time to learn	3 weeks	———	———	———
Average installed cost	———	———	———	———
Typical job-lot size	———	Varies with use	Small lots	Vary with use
Productivity over conventional	———	———	———	———
Designed for N/C?	Specifically	Adapted	Specifically	Adapted
Typical parts produced	Complex airframe parts, die sinking, general machining	Aircraft components and machine tool parts	Complex airframe fittings	Parts for aircraft and machine tools
Additional information				

Company name	The Cincinnati Milling Mach Co	Cincinnati Milling Mach Co	Cleereman Machine Tool Corp	DeVlieg Machine Co
Address	4701 Marburg Ave Cincinnati 9, Ohio	4701 Marburg Ave Cincinnati 9, Ohio	Green Bay Wisconsin	Fair Street Royal Oak, Mich
Tradename or model number	2-Spindle Gantry-Type Skin Milling Machine	Cincinnati 24-in. ATC Machining Center	Spindlemaster	Series 2B, 3H, 4H, 5H Spiramatic Jigmils
Type or function	Airframe skin milling	Automatic tool changer	Drill, ream, tap, bore, mill	Precision bore, mill, drill
Capacity	8 x 30 or 12 x 45 ft	32 x 26 x 24 in.	16 x 24-in. table travel	See additional information
Longest axis of motion	45 ft	32 in.	24 in.	144 in.
Spindle horsepower	50 or 100 hp	Constant 10 hp	3 hp	5 to 30 hp
Number of controlled spindles	Two	One	One	One
Minimum decimal input	0.001 in.	0.0001 in.	0.001 in.	0.0001 in.
Smallest motion increment	0.001 in.	0.0001 in.	0.001 in.	0.0001 in.
Normal operating accuracy	±0.005 in.	± 0.001 in.	±0.001 in.	±0.0001"/ft, positioning acc
Repeatability	±0.0025 in.	± 0.0005 in.	±0.0005 in.	±0.0001 in.
Controlled motions	Longitudinal, transverse, and vertical	3 linear axes plus 1 rotary axis	X, Y and Z	Saddle, table, spindle head, spindle
Degree of control	Contouring	Positioning or contouring	Sequencing and positioning	Sequencing and positioning
Type of data-input media	Punched card	EIA std tape	Tape (not EIA std)	EIA std tape
Feedback?	Yes	Yes	Yes	Yes, also open loop
Type of drive	Rack & pinion & ballscrew	Anti-friction ballscrew	DC motor drive	Depends on size
Speed range	1800 or 3600; incr	33-2000, 58-3300 rpm; incr	100 to 3125 rpm; incr	10 to 1600 rpm; incr
Feed range	0 to 150 ipm; inf adj	1 to 100 ipm; incr	0.4 to 19.8 ipm; incr	.002-.036 (spind); .5-36 (tab)
Control system	Cimtrol Div, Acramatic	Customer's preference	GE, Mark III	DeVlieg, Tapac and Diatrol
Manual operation?	Yes, handwheel or jog button	Yes, loading, unloading only	Yes, push button, selector	Yes, pushbutton and hand
Auxiliary functions	12 auxiliary functions available	Coolant, pallet shuttle, tool selection	All machine functions	Speed & feed changes, depth, table retract, coolant, etc
Automatic tool changer	No	Standard	Standard	———
Normal programming procedure	Computer	Manual	Manual	Manual
Are sub-routines available?	Yes	In near future	———	Not required
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	———	———	105 F	60 to 110 F
Special tool preparation	Yes	Yes	Yes	None
Zero offset range	Full range	Not offered	±0.020 in.	Full range
Zero shifting method	Switch	———	Dial	Manual
Service provisions	Warranty, CMMCo	1-yr warranty, CMMCo	Warranty, Cleereman	Warranty, DeVlieg
Training offered	Yes, in Cincinnati	Yes, at CMMCo, or user's	Yes, at Green Bay	Yes, in Royal Oak
Normal time to learn	3 weeks	———	3 days	One week
Average installed cost	———	———	$70,000	$46,000 to $165,000
Typical job-lot size	———	30 pieces	Up to 100 pieces	2 to 100 (depends on appl)
Productivity over conventional	———	5 to 1	———	120 to 500%
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Large wing skin panels for aircraft	Gear boxes, shifter brackets, valve bodies, airframe members		Precision gear boxes, printing press frames, mach tool parts, jigs and fixtures, etc
Additional information				Company believes in supplying proper machine arranged with best-suited control system, plus necessary tooling. Size range: 2½, 3, 4, 5" dia spindle bars, 36-144" horiz travel; 24-84" vertical travel

N/C Selector Guide—Machines

Company name	Edlund Mach Div of Harsco	Edlund Mach Div of Harsco	Ekstrom, Carlson & Co	Ex-Cell-O Corp
Address	37 Huntington St Cortland, NY	37 Huntington St Cortland, NY	1400 Railroad Ave Rockford, Ill	1200 Oakman Blvd Detroit 32, Mich
Tradename or model number	Edlund-Matic Model 2N	Edlund Model NPB Printed Circuit Board Drill	Eccomil Model No. 200	Numera-Trol Model 922
Type or function	Drilling and tapping	Circuit board drilling	Continuous path milling	Turning, boring, grinding
Capacity	1¼ in.	3/16 in.	From 36 x 48 in. up	Slide travel 18 x 26 in.
Longest axis of motion	20 in.	20 in.	144 in. (longer available)	26 in.
Spindle horsepower	3 hp	———	As required	20 hp
Number of controlled spindles	One	16	One or more	None
Minimum decimal input	0.001 in.	0.001 in.	Depends on control	0.000,020 in.
Smallest motion increment	0.005 in.	0.005 in.	———	0.000,020 in.
Normal operating accuracy	±0.002 in.	±0.002 in.	———	———
Repeatability	±0.001 in.	±0.0001 in.	———	———
Controlled motions	X and Y	X and Y	———	X and Y (linear)
Degree of control	Sequencing and positioning	Sequencing and positioning	Contouring	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Prec leadscrew, DC motor	Prec leadscrew, DC motor	DC or Hydraulic	Servo, hydr ball leadscrew
Speed range	225 to 2700 rpm; inf adj	To 22,000 rpm	———	———
Feed range	1 to 7 ipm; inf adj	10 to 30 ipm, inf adj	———	———
Control system	GE, Mark II	GE, Mark II	GE Mark III, Bendix Dynapath	Bendix, Dynapath 22
Manual operation?	Yes, decade posit, pushbutton	Yes, decade posit, pushbutton	Yes, electric pushbutton	Yes, manual slide controls
Auxiliary functions	Normal	Normal	As required	Six
Automatic tool changer	Optional	———	Optional	———
Normal programming procedure	Manual	Manual	Computer, generally	Computer
Are sub-routines available?	———	———	Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	———	———	50 to 120 F	———
Special tool preparation	None	None	Facilitates tool change	Yes
Zero offset range	±0.020 in.	±0.020 in.	Full	±0.025 in.
Zero shifting method	Dial	Dial	———	———
Service provisions	Warranty, GE & Edlund	Warranty, GE & Edlund	———	Warranty, Ex-Cell-O, Bendix
Training offered	Yes, by GE Waynesboro	Yes, by GE Waynesboro	———	Yes, in Detroit
Normal time to learn	———	———	———	———
Average installed cost	$32,000	$39,000	———	$165,000
Typical job-lot size	1 to 50 parts	One up	———	———
Productivity over conventional	2 to 1	2 to 1	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Average machine parts with multiple hole sizes and operations in same plane	Printed circuit boards		
Additional information				

Company name	Ex-Cell-O Corp	Famco Machine Co	Fosdick Machine Tool Co	Giddings & Lewis Mach Tool Co
Address	1200 Oakman Blvd Detroit 32, Mich	3100 Sheridan Rd Kenosha, Wis	1638 Blue Rock St Cincinnati 23, Ohio	142 Doty St Fond du Lac, Wis
Tradename or model number	Numera-Trol Model 758	Model 100 and 200 Vertical Milling Machines	Fosmatic Models 32, 42, 44, and 54	Numeripoint
Type or function	Precision boring	Milling and drilling	Jig-borers & jig-grinders	Positioning table
Capacity	10 x 10 x 18 in. (patterns)	30 x 10 in.	18x30 to 28x48-in. table	38 x 50 in.
Longest axis of motion	26 in.	30 in.	Up to 48 in.	42 in.
Spindle horsepower	2 hp	1½ & 3 hp	3 hp	———
Number of controlled spindles	Two	One	One	———
Minimum decimal input	0.0001 in.	0.001 or 0.0001 in.	0.0001 in.	0.001 in.
Smallest motion increment	0.0001 in.	0.001 in.	0.0001 in.	0.002 in.
Normal operating accuracy	±0.002 (center); ±0.005 (dia)	±0.0005 in.	±0.0001 in.	±0.001 in.
Repeatability	———	±0.00025 in.	±0.0001 in.	±0.0005 in.
Controlled motions	Table, cross slide, vertical slide, hole size	Longitudinal, cross, and vertical (2 or 3)	X, Y, and Z	X and Y axes
Degree of control	Positioning	Seq, posit, contour available	Sequencing and positioning	Positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	No	Yes
Type of drive	Servo-hydraulic	Hyd cylinder and motor	Mech	AC motor & servo drive
Speed range	½ to 125 ipm; incr	120-4300 (100), 80-2100 (200)	62-2200 or 30-1800; 16 steps	360 ipm traverse
Feed range	½ to 20 ipm; incr	½ to 50 ipm; inf adj	0.0005 to 0.015 ipm; 8 steps	———
Control system	Rheem	Minneapolis-Honeywell	Fosdick, Fosmatic	G&L, Numeripoint
Manual operation?	Yes, entered manually	Yes, handwheels	Yes, pushbutton and mech	Yes, dial input
Auxiliary functions	As required	Start-stop, coolant control, clamping	Coolant control, modes of operation	Coolant control, operation number, tool change light
Automatic tool changer	Optional	No	Optional	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	———	Yes
Safe ambient temperature	———	Normal	68 F for precision required	120 F
Special tool preparation	Yes	Yes	No	None
Zero offset range	Not offered	2 to 5 in.	1/3 travel	Full
Zero shifting method	———	Hydraulic	Mechanical manual	Motor
Service provisions	Warranty, Ex-Cell-O, Rheem	Warranty, by Famco	Warranty, Fosdick	Warranty, G&L
Training offered	Yes, in Detroit	Yes, customer picks location	Yes, in Cincinnati	Yes, in Fond du Lac
Normal time to learn	———	One week	5 days, basic	One week
Average installed cost	$96,000	$33,000 to $67,000	$75,000	$37,500
Typical job-lot size	———	1 to 200	From one up	One to lot sizes
Productivity over conventional	———	2 to 10 times	300 to 600%	At least 30%
Designed for N/C?	Specifically	Modified	Specifically	Specifically
Typical parts produced		Small components	Precision gear cases; missile, gyro, aircraft, jet engine components; multi-hole dies	Any parts, up to 5 tons, normally machined on spacing table; tube sheet work
Additional information			Use of positive measuring system of precision gages	Although this is 2-axis system, other axes can be provided to control drill spindle or rotary table rotation or both. Aux functions (preparatory codes) can select speeds, feeds, coolant, etc

Company name	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co
Address	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis
Tradename or model number	Numeripoint	G&L Series 65 Vertical Boring and Turning Mills	65-ND-16V Numeridrill	65-ND-16HT Numeridrill
Type or function	Rotary table	Vertical boring, turning	Vertical drilling, tapping	Horiz drilling, tapping
Capacity	30 to 120-in. platen	54 in. to 20 ft	38 x 50 in.	36" vert, 42" horiz
Longest axis of motion	500 in.	120 in.	42 in.	42 in.
Spindle horsepower	drive hp not determined	30 to 100 hp (machine)	15 hp	15 hp
Number of controlled spindles	———	One	One	One
Minimum decimal input	———	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	———	0.001 in.	0.002 in.	0.002 in.
Normal operating accuracy	———	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	———	±0.0005 in.	±0.0005 in.	±0.0005
Controlled motions	Table motion	Ram, saddle of 2 heads, and table rotation	X, Y, and Z	X, Y, and Z
Degree of control	Positioning	Seq, posit, limited contouring	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	AC traverse, DC servomotor	Servoclutches in feed boxes	AC motor, servo drive	AC motor & servo drive
Speed range	1 rpm (see addl info)	5-144, .42-22.5 rpm; 16 steps	3 ranges, 30-3000 rpm; incr	3 ranges 30-3000 rpm; incr
Feed range	0.01 to 1.0 ipm; inf adj	0.0007 to 0.50 ipm; 16 steps	.001-.040, .004-.125 ipr; incr	.001-.040, .004-.125 ipr; incr
Control system	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint
Manual operation?	Yes, crank or pushbutton	Yes, standard controls	Yes, dialed input	Yes, dialed input
Auxiliary functions	Clamp	Coolant, threading, tapers, drum scoring, turret rotation	Spindle cycle, coolant, tool change light, sequence no.	Spindle cycle, coolant, tool change light
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	110 F	120 F	120 F
Special tool preparation	No	Yes	None	None
Zero offset range	Full 360°	Full travel	Full	Full
Zero shifting method	Motor	Declutch and manual	Motor	Motor
Service provisions	Warranty, G&L	Warranty, G&L	Warranty, G&L	Warranty, G&L
Training offered	Yes, in Fond du Lac	Yes, at Fond du Lac	Yes, in Fond du Lac	Yes, at Fond du Lac
Normal time to learn	One week (probably)	10 working days	One week	One week
Average installed cost	Not determined	$145,000 to $500,000	$56,000	$54,700
Typical job-lot size	———	5 to 50	One to lot size	One to lot size
Productivity over conventional	———	———	At least 30%	At least 30%
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	None yet. However basic accuracy should allow multiple setup jobs		Designed for tube sheet and similar work; none produced yet	Designed for tube sheet and similar work
Additional information	Can be furnished as positioning device only or with milling feeds. Can be put on sliding platen with rapid traverse or milling feed. Either controlled from own control or G&L machine		For use with G&L positioning table having Numeripoint controls which also operate machine	For use with G&L positioning table having Numeripoint controls which also operate machine

Company name	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co
Address	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis
Tradename or model number	65-F3-T and 65-F4-T table-type horizontal machines	65-C4-F and 65-C5-F floor-type horizontal machines	65-H5-F and 65-H6-F floor-type horizontal machines	65-H5-T and 65-H6-T table-type horizontal machines
Type or function	Horiz boring, milling, drilling	Boring, drilling, milling	Boring, drilling, milling	Boring, drilling, milling
Capacity	3 or 4-in. spindle dia	4 or 5-in. spindle dia	5 or 6-in. spindle dia	5 or 6-in. spindle dia
Longest axis of motion	84 in.	500 in.	500 in.	144 in.
Spindle horsepower	20 hp	25 hp	40 hp	40 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.0001 in.	0.0001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	———	———	———	———
Normal operating accuracy	±0.0002 in./ft	±0.0002 in./ft	±0.0002 in./ft	±0.0002 in./ft
Repeatability	±0.0002 in.	±0.0002 in.	±0.0002 in.	±0.0002 in.
Controlled motions	Horizontal, vertical, and lateral	Horizontal and vertical	Horizontal and vertical	Horizontal, vertical and lateral
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Clutch-servo	Servomotor	Clutch-servo	Clutch-servo
Speed range	9-1600 or 6.9-1330 rpm; incr	3 ranges, 10-1200 rpm; incr	5.6 to 1020 rpm; incr	5.6 to 1020 rpm; incr
Feed range	0.011 to 140 ipm; incr	½ to 40 ipm; inf adj	0.012 to 120 ipm	0.012 to 120 ipm
Control system	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint
Manual operation?	Yes, pushbutton control	Yes, pushbutton station	Yes, pushbutton pendant	Yes, pushbutton pendant
Auxiliary functions	Automatic spindle cycling, and automatic machining	Automatic spindle cycling, auto machining	Automatic spindle cycling, auto-machining	Automatic spindle cycling, automatic machining
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	120 F	120 F	120 F
Special tool preparation	None	None	None	None
Zero offset range	Full	Full range	Full range	Full
Zero shifting method	Motor	Motor	Motor	Motor
Service provisions	Warranty, G&L	Warranty, G&L	Warranty, G&L	Warranty, G&L
Training offered	Yes, in Fond du Lac	Yes, in Fond du Lac	Yes, in Fond du Lac, Wis	Yes, in Fond du Lac
Normal time to learn	5 days	5 days	5 days	5 days
Average installed cost	$90,000	$100,000	$155,000	$125,000
Typical job-lot size	No restriction	No restriction	No restriction	No restriction
Productivity over conventional	———	———	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced		Castings for machine beds, die blank holders, housings for elec equip, weldments		Rocket motor parts, press frames, tube sheets, housings, dies and molds
Additional information		Although these are floor-type machines, other axes can be provided by positioning sliding or rotary table, (or both) thru machine's N/C unit. Machines have individual servo drive for each axis		Horizontals have extra rigidity necessary for proper performance with auto controls. Examples: 3 ways on column, saddle extension wings cast integrally with base, more internal ribbing

N/C Selector Guide—Machines

Company name	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co
Address	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis
Tradename or model number	65-N6-F, 65-N7-F, 65-N8-F floor-type horizontal machines	65-P8-F and 65-P10-F floor-type horizontal machines	No. 3 Jigborer	Series 65, with 32" table, 42" swing, 42 x 52", 52 x 62"
Type or function	Boring, drilling, milling	Boring, drilling, milling	Table-type horizontal	Vertical turret lathe
Capacity	6, 7, or 8-in. spindle dia	8 or 10-in. spindle dia	3-in. spindle dia	See above
Longest axis of motion	500 in.	500 in.	36 to 60 in.	69 in.
Spindle horsepower	75 hp	100 hp	10 hp	30 to 60 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.0001 in.	0.0001 in.	0.0001 in.	0.001 in.
Smallest motion increment				0.001 in.
Normal operating accuracy	±0.0002 in./ft	±0.0002 in./ft	±0.0002 in./ft	±0.001 in.
Repeatability	±0.0002 in.	±0.0002 in.	±0.0002 in.	±0.0005 in.
Controlled motions	Horizontal and vertical	Horizontal and vertical	Horizontal, vertical, and lateral	Ram, saddle of 2 heads, and table rotation
Degree of control	Sequencing and positioning	Positioning	Sequencing and positioning	Seq, posit, limited contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape (proposed)
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Clutch-servo	Clutch servo	Clutch-servo	Clutches from feed boxes
Speed range	3 to 670 rpm; incr	2.7 to 569 rpm; incr	12.6 to 1600 rpm; incr	3 to 380 rpm; 16 steps
Feed range	0.012 to 140 ipm; incr	0.012 to 140 ipm; incr	0.012 to 120 ipm; incr	0.0007 to 0.756 ipr; 16 steps
Control system	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint	G&L, Numeripoint
Manual operation?	Yes, pushbutton pendant	Yes, pushbutton pendant	Yes, pushbutton station	Yes, conventional modes
Auxiliary functions	Automatic spindle cycling, automatic machining	Automatic machining	Automatic machining	Coolant control, threading taper, and drum scoring
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?				
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	120 F	120 F	110 F
Special tool preparation	None	None	None	Yes
Zero offset range	Full	Full	Full range	Full travel
Zero shifting method	Motor	Motor	Motor	Manual
Service provisions	Warranty, G&L	Warranty, G&L	Warranty, G&L	Warranty, G&L for 1 year
Training offered	Yes, in Fond du Lac	Yes, in Fond du Lac	Yes, in Fond du Lac	Yes, in Fond du Lac
Normal time to learn	5 days	5 days	5 days	10 working days
Average installed cost	$225,000	$380,000	$75,000	$100,000 to $125,000
Typical job-lot size	No restriction	No restriction	No restriction	5 to 50
Productivity over conventional				35 to 60% savings
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced			Manifold blocks, engine parts, jigs, machine parts, die blocks, transmission units	Valves, rocket motor parts, cover plates, rings, bushings, spacers, collars, gears
Additional information			Alignment tolerances are much more strict than for horizontals and most of machine's parts are made by tape control. Drives other than that listed can be furnished on request	16 stepped speeds are under tape control, however, speed is infinitely adjustable under manual control

Company name	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co	Giddings & Lewis Mach Tool Co
Address	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis	142 Doty St Fond du Lac, Wis
Tradename or model number	G&L Series 65 Vertical Turret Lathes	G&L Series 65 continuous path vertical machines	DiMil	5-Axis Variax
Type or function	Continuous path VTL	Boring and turning mill	Profiler	Profiler
Capacity	32, 42, or 52 in.	54 in. to 20 ft	36x60" to 72x240" table	48 x 168 in. up
Longest axis of motion	69 in.	120 in.	240 in.	168 in. up
Spindle horsepower	30 to 60 hp (machine)	30 to 100 hp (machine)	30 hp	30 hp
Number of controlled spindles	One	One	Up to 3	One
Minimum decimal input	0.0002 in.	0.0002 in.	0.0002 in.	0.0002 in.
Smallest motion increment	0.0002 in.	0.0002 in.	0.0002 in.	0.0002 in.
Normal operating accuracy	±0.0005 in./ft	±0.0005 in./ft	±0.0001 in./ft	±0.0002 in./ft
Repeatability	±0.0002 in./ft	±0.0002 in./ft	±0.0001 in./ft	±0.0001 in./ft
Controlled motions	Ram and saddle of 2 heads and table rotation	Ram and saddle of 2 heads and table rotation	X, Y, and Z	All five motions controlled simultaneously
Degree of control	Contouring	Contouring	Contouring	Contouring
Type of data-input media	EIA std tape; magnetic tape	EIA std tape; magnetic tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Electric or hydraulic	Electric or hydraulic	Electric or Hydraulic	Electric or hydraulic
Speed range	3 to 380 rpm; incr or inf adj	5-144 to .42-22.5 rpm; incr	8½ to 5400 rpm; incr	40 to 3600 rpm; incr
Feed range	0.007 to 0.756 ipr; inf adj	0.0007 to 0.50 ipr; inf adj	0 to 180 ipm; inf adj	0 to 180 ipm; inf adj
Control system	Mark Century, Dynapath, TRW	Mark Century, Dynapath, TRW	Dynapath, Mark Century, TRW	Dynapath, Mark Century, TRW
Manual operation?	Yes, pendant controls	Yes, pendant controls	Yes, controls on head	Yes, pendant
Auxiliary functions	Coolant, speeds, clamping, and all others	Speeds, coolant, clamping, and all others	Speed selection, coolant, clamping, and others	Speed selection, coolant, clamping, and others
Automatic tool changer	No	No	No	No
Normal programming procedure	Computer	Computer	Computer	Computer
Are sub-routines available?	Some	Some	Sometimes	Sometimes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	Depends on control	Depends on control	Depends on control	Depends on control
Special tool preparation	Yes	Yes	Yes	Yes
Zero offset range	Full range	Full range	Full range	Full range
Zero shifting method	Grid shift	Grid shift	Grid shift	Grid shift
Service provisions	Warranty, G&L	Warranty, G&L	Warranty, G&L	Warranty, G&L
Training offered	Yes, in Fond du Lac	Yes, in Fond du Lac	Yes, in Fond du Lac	Yes, in Fond du Lac
Normal time to learn	One week	One week	One week	
Average installed cost	$200,000 to $300,000	$200,000 to $300,000	$200,000 to $300,000	$400,000
Typical job-lot size			Small lots	Small lots
Productivity over conventional		1 to 30, average 3		43%
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced		Machining oil well drilling equipment such as valves and casing heads	Profiling, contouring, or die-sinking in airframe parts, rocket motor parts, dies	Contouring or profiling airframe, missile, or other parts needing 5-axis motion
Additional information			Useful where high degree of rigidity is demanded for 3-axis work. It is also offered with bridge-type structure with vertical spindle. Multiple spindles optional for simul work on several parts	By using tools set to predetermined length, column swivel and head tilt can be made to rotate about tip of cutter nose. This reduces programming calculations

Company name **Address** **Tradename or model number**	**Giddings & Lewis Mach Tool Co** 142 Doty St Fond du Lac, Wis Skin Mill	**Gisholt Machine Co** 1245 E Washington Ave Madison 10, Wis **Fastermatic**	**Gisholt Machine Co** 1245 E Washington Ave Madison 10, Wis Factrol	**George Gorton Machine Co** 1321 Racine St Racine, Wis Gorton Rail Mill
Type or function **Capacity** **Longest axis of motion** **Spindle horsepower** **Number of controlled spindles**	Machine airframe parts 8 to 12-ft wide, to 50' long 50 ft 100 hp Two	Automatic turret lathe ——— 16 in. 15 to 30 hp One	Automatic turret lathe Equiv to Gisholt 1L, 2L, 3L 38⅜ in. 25 to 30 hp One	3-D contour milling 22 x 32-in. bed 32 in. 2 hp One
Minimum decimal input **Smallest motion increment** **Normal operating accuracy** **Repeatability** **Controlled motions** **Degree of control**	0.0002 in. 0.0002 in. ±0.0005 in./ft ±0.0002 in./ft X, Y, and Z axes, with 2 heads simultaneous Contouring	⅛ in. ⅛ in. ±0.001 in. ±0.001 in. Turret traverse and feed Sequencing	0.001 in. 0.001 in. ——— ——— Two on turret, two on cross slide Contouring	0.0001 in. ——— ±0.001 in. ±0.001 in. Cross, longitudinal, and vertical Contouring
Type of data-input media **Feedback?** **Type of drive** **Speed range** **Feed range**	——— Yes Electric or hydraulic 40 to 3600 rpm; incr 0 to 180 ipm; inf adj	EIA std tape No Hydraulic cylinder 33 to 1725 rpm; incr 1.17 to 36.2 ipm; 16 steps	Magnetic tape Yes Cylinders 20 to 1200 rpm; incr 0 to 10 ipm; inf adj	EIA std tape Yes Hydraulic 65 to 4600 rpm; inf adj ¼ to 30 ipm; inf adj
Control system **Manual operation?** **Auxiliary functions** **Automatic tool changer** **Normal programming procedure** **Are sub-routines available?**	Mark Century, Dynapath, TRW Yes, pendant Speed selection, coolant, clamping, and others No Computer Sometimes	Westinghouse, Prodac Yes, pushbuttons Spindle speed, turret facing, dwell, tool relief No Manual No	Gisholt, Factrol Yes, resolvers on console All No Analog computer ———	TRW Director Control System No 20 available for coolant, spindle, fixturing, and others No Computer Yes
Fail-safe devices? **Safe ambient temperature** **Special tool preparation** **Zero offset range** **Zero shifting method**	Yes Depends on control Yes Full range Grid shift	Yes 100 F Yes Not offered ———	Yes 120 F None ±0.050 long, ±0.025 cross Phase	Yes 65 to 110 F Available as required ±0.040 in. (auto); full (man.) Electronic readout
Service provisions **Training offered** **Normal time to learn** **Average installed cost** **Typical job-lot size** **Productivity over conventional** **Designed for N/C?**	Warranty, G&L Yes, in Fond du Lac One week $500,000 Small lots 35% Specifically	Warranty, Gisholt Yes, at Madison One week $40,000 25 to 50 4 to 1 Adapted	——— Yes, by Gisholt 16 hours ——— 5 to 50 ——— Specifically	Warranty, Gorton and TRW Yes, customer's plant 2 weeks $100,000 25 Up to 2 to 1 Secifically
Typical parts produced	Contouring, profiling, and die-sinking of airframe parts, missile parts, templets, dies	Commutator V-rings	Any standard turret lathe part, plus arcs and slopes	Production profiling inside or outside of complex shapes, extruding dies, blades
Additional information	Patented hydraulic head counterbalancing system eliminates usual problems of planer-type mill. This gives degree of accurate performance vital to operation with N/C			

Company name **Address** **Tradename or model number**	**G A Gray Co** 3611 Woodburn Ave Cincinnati 7, Ohio No. 550, 660, 670, 770, 780, 880 Horizontal Machines	**G A Gray Co** 3611 Woodburn Ave Cincinnati 7, Ohio ———	**The Heald Machine Co** 10 New Bond St Worcester, Mass Healdrill	**The Heald Machine Co** 10 New Bond St Worcester, Mass Heald Model S Boremattic
Type or function **Capacity** **Longest axis of motion** **Spindle horsepower** **Number of controlled spindles**	Boring, drilling, milling 5, 6, 7, or 8-in. spindle 65 ft (longer available) Up to 100 hp One	Planer-type milling machine Up to 12'x12'x any length Any (20 to 30 ft typical) Up to 100 hp ———	Drilling, reaming, tapping 24 x 56-in. table 48 in. 5 hp One	Contour boring & turning To suit Up to 50 in. As required One or two
Minimum decimal input **Smallest motion increment** **Normal operating accuracy** **Repeatability** **Controlled motions** **Degree of control**	0.001 in. 0.001 in. ±0.001 in. ±0.0005 in. Column, table, saddle, head, cross travel Positioning	0.001 in. 0.001 in. ±0.001 in. ±0.0005 in. Table and heads Positioning	0.001 in. 0.001 in. ±0.001 in. ——— Table X and Y, spindle depth by auxiliary function Sequencing and positioning	0.000,020 in. 0.000,020 in. ±0.0001 in. ±0.0001 in. Table and cross slide Sequencing and contouring
Type of data-input media **Feedback?** **Type of drive** **Speed range** **Feed range**	EIA std tape Digital feedback transducer Var voltage DC 0 to 120 ipm; inf adj 0 to 120 ipm; inf adj	EIA std tape Digital feedback transducer Var voltage DC, 20 hp track 0-300 (table), 0-120 (heads) 0-125 (table), 0-120 (heads)	EIA std tape Yes Servo feed, ballscrews 30-1800 rpm; 16 steps 0.002 to 0.030 ipr; 8 steps	EIA std tape Yes Servo feed, ballscrews To 1500 rpm (tbl); inf adj To 30 ipm (tbl & sld); inf adj
Control system **Manual operation?** **Auxiliary functions** **Automatic tool changer** **Normal programming procedure** **Are sub-routines available?**	Norden 100, 500, 600 Yes, pendant control As required No Manual Not required	Norden 100, 500, 600 Yes, pendant control As required No Manual Not required	Cincinnati, Acramatic Yes, decade switches Speed, feed, depth, coolant, tool change signal No Manual ———	Customer's choice Yes, switches As required No Computer Yes
Fail-safe devices? **Safe ambient temperature** **Special tool preparation** **Zero offset range** **Zero shifting method**	Yes Any shop environment Only if Z-axis programmed Full range Digital offset	Yes Any shop environment ——— Full range Digital offset	Yes 100 F (approx) Yes Full range Manual	Yes 100 F (approx) Yes Full range Manual
Service provisions **Training offered** **Normal time to learn** **Average installed cost** **Typical job-lot size** **Productivity over conventional** **Designed for N/C?**	Warranty, Norden Yes, Norden or Gray factory 1 to 3 weeks $150,000 to $450,000 Small ——— Minor changes	Warranty, Norden Yes, Norden or Gray factory 1 to 3 weeks $300,000 to 500,000 Small ——— Minor changes	Warranty, Heald & CMMCo Yes, by Heald & CMMCo Two weeks $46,000 to $50,000 Small lot sizes ——— Specifically	Warranty, Heald & control mfr Yes, by Heald & control mfr 2 weeks $100,000 to $200,000 ——— Up to 90% increase Specifically
Typical parts produced	Machine parts, large frames, reactor housings and grid plates, gearbox housings	Large parts requiring heavy metal removal and good finish, squareness, parallelism	Large variety	Contour surfaces of revolution, misc male and female flat templets
Additional information	Absolute digital system with full zero offset eliminates scrapping large, valuable parts. Digital readout can be furnished without tape or dial read-in. Machine command can be added later	Speeds and feeds are inf adj. Zero-offset is required because it is impossible to make a precision setting of multi-ton workpieces.	Spindle has 4¾-in. dia	Equipment can be furnished for remote control operation and equipped for operation in hazardous areas

Company name	Walter P Hill, Inc	Hillyer Corp	Hillyer Corp	Hillyer Corp
Address	22183 Telegraph Rd Southfield, Mich	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ
Tradename or model number	Special machines 3x3x3' to 10x10'x26" to 90x4x4'	18-P (Printed Circuit Board Drilling Machine)	24-C & 36-C (posit ranges: 24x24" and 36x36")	HB-20A
Type or function	Drilling, boring	Milling, drilling, boring	Drilling	Drilling and milling
Capacity	See above	4 areas, each 18 x 12 in.	⅝-in. drill in steel	Drill ½ in. in steel
Longest axis of motion	300 ft	18 in.	24 in.; 36 in.	19 in.
Spindle horsepower	Up to 100	⅛ hp	1 hp	1 hp
Number of controlled spindles	Up to 6	Four	One	One
Minimum decimal input	0.0001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.0005 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0003 in.	±0.0005 in.	±0.0005 in.	±0.0005 in.
Controlled motions	Up to 6	X and Y axes	X and Y axes	X and Y axes
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	All types	AC motor	Servo drive	Servo drive
Speed range	Job requirements	2500 to 15000 rpm; inf adj	860 to 3450 rpm; 4 steps	80 to 2720 rpm; 8 steps
Feed range	Up to 150 ipm	1 to 60 ipm; inf adj	0 to 50 ipm; inf adj	0.0015, 0.003, and 0.006 ipr
Control system	GE Mark systems	Hillyer	Hillyer	Hillyer
Manual operation?	Yes, button	Yes, by dial	Yes, by dial input	Yes, by dial input
Auxiliary functions	Any required	Feeds, speeds, depth control, coolant on/off, tool change	Coolant on/off and tool change indicator	Coolant on/off, tool change indicator
Automatic tool changer	Optional	No	No	No
Normal programming procedure	Computer	Manual	Manual	Manual
Are sub-routines available?	Yes			
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	150 F	120 to 130 F	120 to 130 F	120 to 130 F
Special tool preparation	Yes on some, no on others	None	None	None
Zero offset range	Full range	Full range	Full range	Full range
Zero shifting method	Motor	Declutch digitizer, reset	Declutch digitizer, reset	Declutch digitizer, reset
Service provisions	Warranty, Hill	Warranty, Hillyer	Warranty, Hillyer	Warranty, Hillyer
Training offered	Yes, Southfield	Yes, at customer's plant	Yes, in customer's plant	Yes, in customer's plant
Normal time to learn	3 to 4 days	2 days	Approx 2 days	Approx 2 days
Average installed cost	$50,000 to $500,000	$25,000 to $30,000	$18,000	$12,000
Typical job-lot size	1 to 1000	Any number	1 to 500 pieces	1 to 500
Productivity over conventional	6 to 1	5 to 1	Approx 3 to 1	3 to 1 (approx)
Designed for N/C?	Specifically	Specifically	Specifically	Adapted
Typical parts produced		Printed circuit boards	Flat parts that need a large number of same size holes drilled to same depth	Any parts normally done on a toolroom mill
Additional information			Inf adj speed is optional	

Company name	Hillyer Corp	Hillyer Corp	Hillyer Corp	Hillyer Corp
Address	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ
Tradename or model number	F-24C and F-36C (24x24 in. and 36x24 in. posit range)	T-24C & T-36C, MT-24C & MT-36C (24x24" and 36x24")	H-24C & H-36C (with 24x24" and 36x24" posit range)	HF-24C & HF-36C (Posit range: 24x24" and 36x24")
Type or function	Drilling, tapping, milling	Drilling, tapping	Drilling	Drill, tap, mill (straight line)
Capacity	Drilling ¾-in. in steel	Drilling ½-in., ⅞-in. in steel	Drill 1¼-in. in steel	Drill 1¼ in. in steel
Longest axis of motion	24 in.; 36 in.	24 in.; 36 in.		24 in.; 36 in.
Spindle horsepower	5 hp	1 hp, 2 hp	5 hp	7½ hp
Number of controlled spindles	One	8, 5	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±0.0005 in.
Controlled motions	X and Y axes	X and Y axes	X and Y axes	X and Y axes
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Servo drive	Servo drive	Servo drive	Servo drive
Speed range	400 to 2600 rpm; incr	400-2600, 300-1900 rpm	250 to 1500 rpm; inf adj	250 to 1500 rpm; incr
Feed range	1-11, 3-21 ipm; incr	1 to 11 ipm; incr	0 to 50 ipm; inf adj	1-11 and 3-21 ipm; incr
Control system	Hillyer	Hillyer	Hillyer	Hillyer
Manual operation?	Yes, by dial input	Yes, by dial input	Yes, by dial input	Yes, by dial input
Auxiliary functions	Tapping, milling, dwell, peck, cooling, speeds, feeds	Tapping, coolant on/off, depth, dwell, peck drilling	Coolant on/off and depth control	Tap, mill, speeds, feeds, depth, dwell coolant, peck
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?				
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 to 130 F	120 to 130 F	120 to 130 F	120 to 130 F
Special tool preparation	None	None	None	None
Zero offset range	Full range	Full range	Full range	Full range
Zero shifting method	Declutch digitizer, reset	Declutch digitizer, reset	Declutch digitizer, reset	Declutch digitizer, reset
Service provisions	Warranty, Hillyer	Warranty, Hillyer	Warranty, Hillyer	Warranty, Hillyer
Training offered	Yes, in customer's plant	Yes, in customer's plant	Yes, in customer's plant	Yes, in customer's plant
Normal time to learn	Approx 2 days	Approx 2 days	Approx 2 days	Approx 2 days
Average installed cost	$30,000	$30,000, $31,000	$26,000	$32,000
Typical job-lot size	1 to 5000 pieces	1 to 500 pieces	1 to 500 pieces	1 to 500 pieces
Productivity over conventional	3 to 1, approx	4 to 1	4 to 1	4 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Drilling, reaming, counterboring, and straight-line milling operations		Flat parts with large number of the same size holes, such as condenser sheets	
Additional information		Equipped with eight-station turret		

Company name	Hillyer Corp	Hillyer Corp	Hillyer Corp	Hughes Indus Systems Div
Address	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ	244 Sheffield St Mountainside, NJ	PO Box 90904 Los Angeles 9, Calif
Tradename or model number	F-24D, F-36D, F-48D, F-60D (24x24" to 60x36")	H-24D, H-36D, H-48D, H-60D, (from 24x24" to 60x36")	TC-24D, TC-36D, TC-48D, and TC-60D	MT-3
Type or function	Drill, tap, mill, bore	Drilling 1¼-in. in steel	Drill, tap, mill, bore	Machining center
Capacity	Drill 1¼-in. in steel	60 in.	Drill 1¼-in. steel	12 x 12 x 24 in.
Longest axis of motion	60 in.	7½ hp	60 in.	24 in.
Spindle horsepower	7½ hp	One	7½ hp	10 hp
Number of controlled spindles	One		One	3 heads
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.0005 in.	±0.0003 in.
Controlled motions	X and Y axes	X and Y axes	X and Y axes	2 table motions, 16-step indexing, spindle head travel
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Servo drive	Servo drive	Servo drive	———
Speed range	400 to 2600 rpm; incr	250 to 1500 rpm; inf adj	150 to 3000 rpm; incr	40 to 4000 rpm; 28 steps
Feed range	1 to 11 ipm; incr	0 to 50 ipm; inf adj	1 to 50 ipm; incr	1 to 75 ipm; 31 steps
Control system	Hillyer	Hillyer	Hillyer	Hughes MT-3
Manual operation?	Yes, by dial input	Yes, by dial input	Yes, by dial input	Yes, dial, man. switches
Auxiliary functions	Tap, mill, speeds, feeds, depth, dwell, coolant	Coolant on/off and depth control	Tap, mill, speeds, feeds, depth, dwell, coolant	Feed, speed, tool selection, coolant control
Automatic tool changer	No	No	Standard	Standard
Normal programming procedure	Manual	Manual	No	Manual
Are sub-routines available?	———	———	Manual	In process
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 to 130 F	120 to 130 F	120 to 130 F	100 F
Special tool preparation	None	None	None	Yes
Zero offset range	Full range	Full range	Full range	Not required
Zero shifting method	Declutch digitizer, reset	Declutch digitizer, reset	Declutch digitizer, reset	———
Service provisions	Warranty, Hillyer	Warranty, Hillyer	Warranty, Hillyer	Warranty, Hughes
Training offered	Yes, in customer's plant	Yes, in customer's plant	Yes, in customer's plant	Yes, at Hughes or user's
Normal time to learn	Approx 2 days	Approx 2 days	Approx 2 days	2 weeks
Average installed cost	$35,000 to $40,000	$35,000 to $40,000	$55,000 to $65,000	$122,500
Typical job-lot size	1 to 500 pieces	1 to 500 pieces	1 to 500 pieces	1 to 2000 pieces
Productivity over conventional	4 to 1	4 to 1	4 to 1	6 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Ferrous or non-ferrous needing drilling, tapping, reaming, straight line milling	Flat parts with large number of same size holes, such as condenser sheets	Parts needing drilling, tapping, boring, straight-line milling	Castings, forgings, prototype parts from solid stock
Additional information			For applications where customer requires 100% automatic operation including automatic tool changing	Designed on building block concept. Basic machine is central work station and universal head with 30-tool magazine. Additional heads include 10-hp milling head, 14-tool precision boring head
Company name	Ingersoll Milling Machine Co	Jones & Lamson Machine Co	Jones & Lamson Machine Co	Jones & Lamson Machine Co
Address	707 Fulton St Rockford, Ill	502 Clinton St Springfield, Vt	502 Clinton St Springfield, Vt	502 Clinton St Springfield, Vt
Tradename or model number	Ingersoll Tape Controlled Milling Machine	12 x 20-in. and 20 x 20-in. N/C Positioning Table	30 x 40-in. N/C Positioning Table	2½-in. x 21-in. N/C Turret Lathe
Type or function	Mill, drill, bore, tap	Positioning	Positioning	Contour turning
Capacity	120" (long), 36" (tran), 24"(v)	1000-lb load	4000-lb load	2½-in. bar, 12-in. chuck
Longest axis of motion	120 in.	20 in.	40 in.	24 in.
Spindle horsepower	50 hp	———	———	30 hp
Number of controlled spindles	One	———	———	One
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.0001 in.
Smallest motion increment	———	0.001 in.	0.002 in.	0.001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.002 in.	±0.001 in.
Repeatability	———	±0.0005 in.	±0.001 in.	±0.0005 in.
Controlled motions	Longitudinal, transverse, and vertical motions	X and Y table movements	X and Y table movements	Carriage, cross slide, and saddle
Degree of control	Sequencing and positioning	Positioning	Positioning	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Ballbearing screw & nut	Electric-hydraulic	Electric or hydraulic	Electrical-hydraulic
Speed range	40 to 368 rpm; inf adj	10 in. in 3.5 sec	120 ipm	40 to 2000 rpm; incr
Feed range	See addl info	180 ipm	———	0.50 to 30 ipm; inf adj
Control system	GE Mark III	GE, Bendix, Sperry	GE or Sperry	Mark Century or Dynapath 23
Manual operation?	Yes, buttons on control	Yes, dial or pushbutton	Yes, pushbutton	Yes, for checkout only
Auxiliary functions	Speed, feed, coolant on/off	Depends on application	Depends on application	Index front & rear square hex; control coolant, bar feed, etc
Automatic tool changer	No	Optional	———	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	No	Yes	Yes	Yes
Safe ambient temperature	———	100 F	120 F	120 F
Special tool preparation	Only cutter dia ±0.005 in.	None	None	Yes
Zero offset range	Full range	Full range	Full range	0.025 in. (min)
Zero shifting method	———	Manual	Clutch	Manual dial
Service provisions	Warranty, Ingersoll	Warranty, J&L & control mfr	Warranty, J&L & control mfr	Warranty, J&L & control mfr
Training offered	Yes, in Rockford	Yes, J&L & control mfr	Yes, J&L & control mfr	Yes, J&L & control mfr
Normal time to learn	———	3 to 10 days	3 to 10 days	Two weeks
Average installed cost	———	$32,000	$30,000	$100,000 to $150,000
Typical job-lot size	One to ten	50 or less	50 or less	100 and below
Productivity over conventional	25% (1st piece), 10% (2nd)	———	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Gear boxes, transfer bars (60 to 120-in. weldments) machined in one setup	Drilling holes in any ferrous or non-ferrous material	Drilling holes in any ferrous or non-ferrous material	Normal turret lathe parts plus tapers, radii, and specialized curves
Additional information	Feeds: Table, 3-120 ipm; head, 1½-60 ipm; quill, ½-20 ipm; all inf adj. Machine designed for 1-to-5 piece lots that repeat 3 or 4 times a yr. Materials handling savings is made, since setup shortened			On small lots, pre-programmed tape and quick-change, preset tooling slashes setup time. High-speed indexing & traverse, simultaneous actions, buffer storage cut cycle time

Company name	Jones & Lamson Machine Co	Kearney & Trecker Corp	Kearney & Trecker Corp	Kearney & Trecker Corp
Address	502 Clinton St Springfield, Vt	6800 W National Ave Milwaukee 14, Wis	6800 W National Ave Milwaukee 14, Wis	6800 W National Ave Milwaukee 14, Wis
Tradename or model number	4½-in. x 32-in. (or x 21-in.) N/C Turret Lathe	Milwaukee-Matic Model II	Milwaukee-Matic Model II-III	Milwaukee-Matic Model III
Type or function	Contour turning	Manufacturing machine	Manufacturing machine	Manufacturing machine
Capacity	4½" bar, 12 or 15" chuck	18-in. cube	36-in. cube	36-in. cube
Longest axis of motion	53½ in.	24 in.	44 in.	44 in.
Spindle horsepower	40 hp (or 30 with 21" swing)	10 hp	10 hp	15 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.0001 in.	0.0001	0.0001 in.	0.0001 in.
Smallest motion increment	0.001 in.	0.0001	0.0001 in.	0.0001 in.
Normal operating accuracy	±0.001 in. (within 24")	±0.0005	±0.0005 in.	±0.0005 in.
Repeatability	±0.0005 in.	±0.0003	±0.0003 in.	±0.0003 in.
Controlled motions	Carriage, cross slide, and saddle	Longitudinal, vertical, depth, and table index	Longitudinal, vertical, depth, and table indexing	Longitudinal, vertical, depth, and table indexing
Degree of control	Contouring	Contouring	Contouring	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic	Hyd servo motors, ballscrews	Hyd servo motors, ballscrews	Hyd servo motors, ballscrews
Speed range	24-1200 or 30-1500 rpm; incr	100 to 4000 rpm; 10 incr	100 to 4000 rpm; 10 rpm incr	50 to 2000 rpm; 10 rpm incr
Feed range	0.50 to 30 ipm; inf adj	1 to 99 ipm; 1 ipm incr	½ to 49 ipm; ½ ipm incr	½ to 49 ipm; 0.1 & 1.0 incr
Control system	Dynapath 23 or Mark Century	GE-Milwaukee-Matic	GE-Milwaukee-Matic	GE-Milwaukee-Matic
Manual operation?	Yes, for checkout only	Yes, Pushbuttons	Yes, pushbuttons	Yes, keyboard
Auxiliary functions	Index front & rear square, hex; coolant, bar feeds, etc	Pallet shuttle, coolant control, tool changing	Pallet shuttle, coolant control, and tool changing	Pallet shuttle, coolant control, and tool changing
Automatic tool changer	No	Standard	Standard	Standard
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F	104 F (special to 122 F)	104 F (special to 122 F)	104 F (special to 122 F)
Special tool preparation	Yes	Yes, preset tooling	Yes, presetting of tools	Yes, preset tooling
Zero offset range	0.025 in. (min)	Not offered	Not offered	Not offered
Zero shifting method	Manual dial	———	———	———
Service provisions	Warranty, J&L & control mfr	Warranty, K&T, GE	Warranty, K&T and GE	Warranty, K&T and GE
Training offered	Yes, J&L & control mfr	Yes, Milwaukee	Yes, in Milwaukee	Yes, in Milwaukee
Normal time to learn	Two weeks	1 to 3 weeks	1 to 3 weeks	1 to 3 weeks
Average installed cost	$180,000	$175,000	$225,000	$280,000
Typical job-lot size	100 and below	One up (avg, 5)	One piece up	One piece up
Productivity over conventional	———	5 to 1, avg	6 to 1	5 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Normal turret lathe parts plus tapers, radii, and specialized curves	Castings, forgings, weldments, and some plate work	Large dia cylindrical and conical parts	Castings, forgings, weldments, and some plate work
Additional information	Tolerance ±0.002 in. on overall stroke. Designed for small lot sizes where pre-programmed tape and quick-change, preset tooling gives drastic setup time reductions.		Has manually inclinable table (45°, sine-bar type) used when working normal to conical surface	

Company name	Kearney & Trecker Corp	Kearney & Trecker Corp	Kearney & Trecker Corp	W B Knight Machinery Co
Address	6800 W National Ave Milwaukee 14, Wis	6800 W National Ave Milwaukee 14, Wis	6800 W National Ave Milwaukee 14, Wis	3920 W Pine St Louis 8, Mo
Tradename or model number	KTNC Skin Mill	KTNC 3-axis Profile and Contour Milling Machine	KTNC 5-Axis Profile and Contour Milling Machine	No. 65
Type or function	Contouring and profiling	Contouring and profiling	Contouring and profiling	Jig borer
Capacity	12x30', 4-ft work height	48 x 168 in. or longer	48 x 168 in. or longer	18 in. x 28 or 36 in.
Longest axis of motion	Up to 90 ft	168 in. or longer	168 in. or longer	36 in.
Spindle horsepower	50/100 hp	20 and 20/40 hp	30 hp (and 20/40)	7½ hp
Number of controlled spindles	Two	One	One	———
Minimum decimal input	0.0005 in.	0.0002 in.	0.0002 in.	0.0001 in.
Smallest motion increment	0.0005 in.	0.0002 in.	0.0002 in.	0.0001 in.
Normal operating accuracy	±0.003 in.	±0.0015 in.	±0.0015 in.	±0.0002 in.
Repeatability	±0.002 in.	±0.001 in.	±0.001 in.	±0.0001 in.
Controlled motions	Longitudinal, cross, and depth	Longitudinal, vertical, and depth (2)	Longitudinal, vertical, depth (2), and head tilt and swivel	X and Y axes
Degree of control	Contouring	Contouring	Contouring	Positioning
Type of data-input media	1" 14-chan AIA std mag tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	DC motor, amplidyne control	Hydraulic servo motors	Hydraulic servo motors	Hydraulic
Speed range	1800/3600; 50/1500; incr	36-1800; 20-3600; incr	40-3600, 20-3600; incr	40 to 2000 rpm
Feed range	0 to 150 ipm; inf adj	0 to 180 ipm; inf adj	0 to 180 ipm; inf adj	None
Control system	GE Mag Tape Contour System	Bendix Dynapath	Bendix Dynapath	Sperry
Manual operation?	Yes, pushbuttons	Yes, pushbuttons and dials	Yes, pushbuttons and dials	No
Auxiliary functions	Coolant control, chip conveyors	Coolant control and clamping	Coolant control and clamping	Depth control
Automatic tool changer	No	Optional	No	No
Normal programming procedure	Computer	Computer	Computer	Manual
Are sub-routines available?	Yes	Yes	Soon	———
Fail-safe devices?	Yes	Yes	Yes	———
Safe ambient temperature	104F	122 F	122 F	———
Special tool preparation	None	Only with tool-changer	None	———
Zero offset range	Full range	Full range	Full range	0.600 in.
Zero shifting method	Manual	Manual	Manual	———
Service provisions	Warranty, K&T, GE	Warranty, K&T, Bendix	Warranty, K&T and Bendix	Warranty, Sperry
Training offered	Yes, in Milwaukee	Yes, in Milwaukee	Yes, in Milwaukee	———
Normal time to learn	2 to 3 weeks	2 to 3 weeks	2 to 3 weeks	———
Average installed cost	$450,000	$250,000	$400,000	$50,000
Typical job-lot size	One up (5 to 20, avg)	One up (5 to 20, avg)	One up (5 to 20, avg)	———
Productivity over conventional	Over 6 to 1	5 to 1, average	Above 4 to 1	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Large sculptured and contoured parts, integral stiffened airframe skin panels	Airframe structural parts, dies	Airframe structural parts and dies	
Additional information				

Company name **Address**	Lahr Machine & Tool Corp 3400 Maplewood Ave Toledo 10, Ohio	Lahr Machine & Tool Corp 3400 Maplewood Ave Toledo 10, Ohio	Lapointe Machine Tool Co 34 Tower St Hudson, Mass	R K LeBlond Machine Tool Co Madison and Edwards Rds Cincinnati 8, Ohio
Tradename or model number	Lahr-Matic	662, 682, 6202	48/48 AUHP	Tape-Turn
Type or function	Drilling, milling, tapping	Gun drilling	Drilling, boring, milling	Turning, facing, boring
Capacity	4x6' planer type, 3° cap	6x6', 6x8', and 6x20'	60" bolt circle, 48" height	2013 to 4025 series
Longest axis of motion	72 in.	240 in.	30" (lin), 360° (rotary)	168 in.
Spindle horsepower	15 hp	30 hp	5 hp	Up to 75 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.0001 in.; 0.001 of degree	0.0001 in.
Smallest motion increment	0.001 in.	0.001 in.	Same	0.001 in.
Normal operating accuracy	±0.002 in.	±0.002 in.	±0.0005 in.	±.001 in. (dia); .001"/ft
Repeatability	±0.0005 in.		±0.0002 in.	
Controlled motions	X, Y, and Z	X and Y	X and C axes	Turret and spindle rotation
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	DC servo	DC	AC servo	Static and rotating
Speed range	25 to 600 rpm; incr	200 to 5000 rpm; inf adj	100 to 2000 rpm; inf adj	To 1500 rpm (small), 650 (lrg)
Feed range	0.0043 to 0.250; incr	1 to 20 ipm; inf adj	0.0025 to 0.021 ipr; inf adj	0.03 to 20 ipm; incr
Control system	Reliance	W&S, Reliance, & GE	Norden Series 400	GE Mark Century
Manual operation?	Yes, dial-in info	Yes, dial-in info	Yes, pushbutton	Yes, manual data input
Auxiliary functions	Tool change, speed, feed, and machine mode	Bush plate, coolant control	Spindle off/on, coolant off/on	Tool retracts, thread cutting, feed clutches, cutting fluid
Automatic tool changer	Standard	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?			No	In future
Fail-safe devices?	Yes	Yes	Yes	
Safe ambient temperature			80 F	140 F
Special tool preparation	Yes	None	None	Available if required
Zero offset range	Full range	Full range	Full range	Machine travel
Zero shifting method	Electronic	Clutch	Manual	Potentiometer
Service provisions	Warranty, Lahr and Reliance	Warranty, Lahr	Warranty, control mfr	Warranty, LeBlond
Training offered	Yes, in Toledo	Yes, in Toledo	Yes, in Hudson	Yes, at LeBlond or user's
Normal time to learn	One week	One week	4 weeks	2 weeks
Average installed cost	$150,000	$90,000 to $130,000	$150,000	$90,000 to $130,000
Typical job-lot size	1 to 50	One	5 to 10 pieces	From 3 up
Productivity over conventional		Better than 2 to 1	2 to 1	4 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Large compressor and gas engine parts of cast iron and steel	Heat exchanger tube plates, deep-hole gun drilling plates or solid up to 24-in. thick	Aircraft engine and missile components	All types of turned parts
Additional information	Machine has 14 to 20 tools available for spindle pickup. Spindle has No. 60 milling machine taper drive with cross keys (pos). Will run completely by tape after loading	Spindle has direct-connected DC drive motor with high pressure coolant hole through spindle. These conditions considered best for gun drilling	Besides the accuracy of machine, its chief feature is ability to take 30,000 lb load	

Company name **Address**	Leland-Gifford Co 1001 Southbridge St Worcester, Mass	Leland-Gifford Co 1001 Southbridge St Worcester, Mass	The Lodge & Shipley Co 3055 Colerain Ave Cincinnati 25, Ohio	Lucas Machine Div New Britain Machine Co Cleveland 8, Ohio
Tradename or model number	Automatic Hole Locator with Specialmatic Controls	PCB Automatic Small Hole Drilling Machine	Numeriturn Lathe	Lucas
Type or function	Sensitive drilling (1-in. cap)	Printed circuit board drill	Contour turning	Boring, drilling, milling
Capacity	15x11" (table); 18" (stroke)	¼" chuck; 15x11 or 19" tbl	2516 & 3220	2-12' vert x 20-170" c' feed
Longest axis of motion	18 in.	19 in.	336 in.	
Spindle horsepower	1 or 3 hp	¾ hp	30 & 50 hp	7½ to 40 hp
Number of controlled spindles	One	1 to 18	One	1 (normal)
Minimum decimal input	0.001 in.	0.001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.005 in. (any 1 direction)	0.005 in. (any 1 direction)	0.0005 in.	0.0001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.002 in.	±0.0003 in.
Repeatability	±0.0005 in.	±0.0005 in.	±0.001 in.	±0.0001 in.
Controlled motions	X, Y, and Z	X and Y with N/C; Z within drill unit by N/C	Carriage and cross slide	Head (vert), table (cross), saddle (long), spindle
Degree of control	Sequencing and positioning	Position, Contour (str line)	Contouring	Contouring
Type of data-input media	See addl information	EIA std tape	EIA std tape, punched tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic	Hydraulic	DC motors, amplidyne mg	Clutch-servo, hyd, Amplidyne
Speed range	100 to 4500 rpm; incr	Up to 21,000 rpm; inf adj	50-1600, 43-1000 rpm; inf adj	5½ to 1800 rpm; 42 steps
Feed range	1 to 30 ipm; inf adj	0.0005 to 0.012 ipr; inf adj	0.1 to 20 ipm; inf adj	0.001 to 1.038 ipr; 81 steps
Control system	Specialties, Specialmatic	GE Mark II or Mark Century	GE Mark Century 102C	GE Mark Con, III, or Accupin
Manual operation?	Yes, normal operation	Yes, selector switch	Yes, dial input	Yes, pushbuttons
Auxiliary functions	Coolant on/off, tapping, tool change light, spindle on/off	Tool change light, spindle selection, coolant	Tool change, coolant, speeds, and feeds	All functions
Automatic tool changer	No	No, 4-station turret head	Standard	Optional
Normal programming procedure	Manual	Manual	Manual	Computer for contouring
Are sub-routines available?	No	No	Apt only	
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	150 F		120 F	Air conditioned
Special tool preparation	None	Yes	Yes	Presetting
Zero offset range	Full range	±0.020 in.; full range	Full range	Full range
Zero shifting method	Manual	Manual; electric	Dial	Potentiometer
Service provisions	Warranty, L-G & Specialties	Warranty, L-G & GE	Warranty, L&S & GE	1-yr warranty, Lucas & GE
Training offered	Yes, L-G, Specialties plant	Yes, at L-G, GE, user's plant	Yes, at L&S & GE	Yes, at Lucas
Normal time to learn	One week	2 days to 2 weeks		One week
Average installed cost	$25,000 to $30,000	$35,000 to $40,000	$100,000	$85,000 to $200,000
Typical job-lot size	5 to 500 pieces	5 to 500 pieces	2 to 100 pieces	One or more
Productivity over conventional	40 to 50%		Depends on job	4 to 1 or more
Designed for N/C?	Partially	Specifically	Specifically	No, modified
Typical parts produced	Any typical drilling job which would require bushings and/or layout plates	Designed for PC boards, but has enough thrust for die plates, templets, sheet steel	OD turning, contour turning, boring and facing, threading	Parts for printing press, missiles, road equipment; toolroom work
Additional information	Control requires no program. Micrometer dial preset for each setup, locked in to end of job lot. Prepunched keys are read photo-electrically and give sequence of operations	Circuit boards stacked 7 high are drilled with no walk. Can be run from programmed tape, or from tape punched on machine itself. Thus, program can be done completely at machine from drawings	Accra-Index tool post, as standard equipment, is completely automatic tool-changing feature. Lathes, designed for N/C, have no standard controls	

N/C Selector Guide—Machines

Company name	Moline Tool Co	Moline Tool Co	The Monarch Machine Tool Co	The Monarch Machine Tool Co
Address	102 20th St Moline, Ill	102 20th St Moline, Illinois	Sidney Ohio	Sidney Ohio
Tradename or model number	Model HD68 Multi-Numetric	Model HF152 Multi-Numetric	Series 62	Series 80
Type or function	Multiple spindle drill	Multiple spindle drill	Turning	Turning
Capacity	1⅛-in. (max) drills	1⅛-in. (max) drills	2013-16	2516-19
Longest axis of motion	89 in.	180 in.	30 to 222" bed lengths	48 to 240" bed lengths
Spindle horsepower	50 hp	120 hp	20 hp	25 hp
Number of controlled spindles	23 in-line	32 in-line	One	One
Minimum decimal input	———	———	0.0001 in.	0.0001 in.
Smallest motion increment	———	———	0.0001 in.	0.0001 in.
Normal operating accuracy	———	———	±0.001 in.	±0.001 in.
Repeatability	———	———	±0.0004 in.	±0.0004 in.
Controlled motions	Table positioning (X and Y) and spindle selection	Position of gantry or bridge on X and Y axis	Transverse (X) and longitudinal (Z)	Transverse (X) and longitudinal (Z)
Degree of control	Sequencing and positioning	Sequencing and positioning	Contouring	Contouring
Type of data-input media	———	———	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	DC motors (positioning)	DC motors (positioning)	Hydraulic	Hydraulic
Speed range	———	———	2.5 to 1250 rpm; inf adj	3.5 to 1750 rpm; inf adj
Feed range	———	———	0 to 48 ipm; inf adj	0 to 48 ipm; inf adj
Control system	GE Mark II	GE Mark II	TRW, GE, Bendix	TRW, GE, Bendix
Manual operation?	Yes, pushbuttons & dials	Yes, pushbuttons	Yes, apron controls	Yes, apron controls
Auxiliary functions	Spindle drill/not drill, automatic shutdown at completion	Select spindles to drill or not drill	Turret position, coolant, traverse, spindle, feed override	Turret position, coolant, traverse, spindle, feed override
Automatic tool changer	No	No	4 or 6-position turret	4 or 6 position turret
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	———	———	Air conditioned	Air conditioned
Special tool preparation	Drills ground in sets	Drills ground in sets	None	None
Zero offset range	Full range	Full range	Infinite zero shift	Infinite zero shift
Zero shifting method	Dials	Mechanical	———	———
Service provisions	———	———	Warranty, Monarch	Warranty, Monarch
Training offered	Yes, in Moline	———	Yes, in Sidney	Yes, in Sidney
Normal time to learn	———	———	———	———
Average installed cost	———	———	———	———
Typical job-lot size	Varies	Varies	Under 30 parts	Under 30 parts
Productivity over conventional	———	———	6 to 10 to 1	6 to 10 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Tube sheets or header plates for heat-transfer equipment	Heat exchanger plates such as for steam condensors in power plants	———	———
Additional information	Handles work fitting its 84-in. square work table. Reduces production time of multiple-hole work; eliminates layout on work prior to drilling	Will drill under tape control anywhere in a 10x15' area. It is gantry type machine, so work remains fixed on stationary table while bridge is positioned over work and drill spindles selected by N/C	Same as Series 80	Multiple cuts may be taken, and a variety of tools used in turret. Heavy 6-position turret is provided for chucking work

Company name	The Monarch Machine Tool Co	Moore Special Tool Co, Inc	Morey Machine Tool Co Inc	Morton Mfg Co
Address	Sidney Ohio	800 Union Ave Bridgeport, Conn	383 Lafayette St New York 3, NY	Broadway & Hoyt Muskegon Heights, Mich
Tradename or model number	Series 91	Moore No. 3 Jig Borer	Morey Model A50	Horizontal Drilling Machine
Type or function	Turning	Jig boring machine	Contour milling	Drilling
Capacity	4025	11 x 24-in. table	48x48" (tbl) 12" stroke	16'x6'x30" bar feed
Longest axis of motion	60 to 252" bed lengths	18 in.	To suit requirements	16 ft
Spindle horsepower	40 hp	2 hp	30 hp	15 hp
Number of controlled spindles	One	None	One	One
Minimum decimal input	0.0001 in.	0.000,010 in.	0.001 in.	0.001 in.
Smallest motion increment	0.0001 in.	0.000,010 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.001 in.	±0.0001	±0.002 in.	±0.002 in.
Repeatability	±0.0004 in.	±0.000,010	0.0005 in.	±0.001 in.
Controlled motions	Transverse (X) and longitudinal (Z)	X and Y axes	Three axes	Horizontal and vertical
Degree of control	Contouring	Sequencing and positioning	Contouring	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	Depends on system	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic	Electric motor	Hydraulic or electric servos	Electro-mechanical
Speed range	1.5 to 750 rpm; inf adj	10 ipm	20 to 3600 rpm; 18 steps	120 to 600 rpm; inf adj
Feed range	0 to 48 ipm; inf adj	———	0 to 180 ipm; inf adj	3 and 600 ipm
Control system	TRW, GE, Bendix	Bendix, Warner & Swasey	Stromberg Carlson, GE, Bendix	GE Mark II
Manual operation?	Yes, apron controls	Yes, manual controls	Yes, pushbuttons, hand wheels	Yes, dial
Auxiliary functions	Turret position, coolant, traverse, spindle, feed override	Clamping and unclamping	Unlimited, depending on customer's requirements	Coolant, spindle speed and feed, tool no. readout
Automatic tool changer	4 or 6-position turret	No	Optional	Optional
Normal programming procedure	Manual	Computer	Manual	Manual
Are sub-routines available?	———	———	Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Normal
Safe ambient temperature	Air conditioned	90 F	110 F	No
Special tool preparation	None	None	None	Full range
Zero offset range	Infinite zero shift	Full range	Floating zero	Clutch
Zero shifting method	———	Button	———	Warranty, Morton
Service provisions	Warranty, Monarch	Warranty, Moore	Warranty, Morey, system mfr	Yes, customer picks location
Training offered	Yes, in Sidney	Yes, customer's plant	Yes, at system mfr's	One week
Normal time to learn	———	1 to 2 days	One week	$130,000
Average installed cost	———	$40,000	$150,000 and up	One or more
Typical job-lot size	Under 30 parts	50 parts	One to mass production	6 to 1
Productivity over conventional	6 to 10 to 1	Depends on job	———	Specifically
Designed for N/C?	Specifically	No, adapted	Specifically	
Typical parts produced	———	Point-to-point contouring of cams, hobs in precision parts	Templets, cams, miscellaneous tooling, experimental parts, replacement or spares	Flat or bridge plates, gussets, etc
Additional information	Same as Series 80		This is a planer type, double column bridge-type vertical spindle mill which can perform conventional milling, contour milling, drilling, boring, and other operations	

Company name	Morton Manufacturing Co	Morton Manufacturing Co	National Automatic Tool Co	Onsrud Machine Works, Inc
Address	Broadway & Hoyt Muskegon Heights, Mich	Broadway & Hoyt Muskegon Heights, Mich	National Road West Richmond, Ind	7710 North Lehigh Ave Niles, Ill
Tradename or model number	Stub-bar Boring Machine	Bridge mill	L7-41	F-30 Gantry
Type or function	Boring, drilling, milling	Bore, drill, mill, tap, etc	Drilling, milling, boring, etc	Mill
Capacity	12' high by 100" dia	100', 2 bridges, 12x18'	See addl information	3 x 50 ft
Longest axis of motion	100 in.	100 ft	36 in.	50 ft
Spindle horsepower	100 hp	4 heads, 150 hp, 75 hp (3)	3 hp	50 hp
Number of controlled spindles	One	Four	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal operating accuracy	±0.002 in.	±0.002 in.	±0.0015 in.	±0.001 in.
Repeatability	±0.001 in.	±0.001 in.	±0.0005 in.	±0.001 in.
Controlled motions	Vertical and radial	Two bridges (total of 10 motions	X, Y, and Z	Horizontal, transverse, and/or vertical
Degree of control	Positioning & steering	Sequencing and positioning	Positioning	Contouring
Type of data-input media	Dial input	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Amplidyne	Electric	Hydro-mechanical	Electric or hydraulic
Speed range	4 to 60 rpm; inf adj	See additional information	50 to 3015 rpm; incr	12-1200, 3600-7200 rpm; incr
Feed range	0.012 to 7.3 ipm; inf adj	See additional information	¼ to 30 ipm; incr	inf adj
Control system	GE, Special (1957)	GE Mark IV and 2 Mark III's	Natco-Trol L7-41	Bendix, GE, TRW
Manual operation?	Yes, dial	Yes, dials	No	Yes, pushbuttons
Auxiliary functions	None	Coolant, tool change, cycles, feeds, speeds, dwell, etc	16, including tool select & change, mill, tap, feed, etc	All necessary
Automatic tool changer	No	Standard	Optional	No
Normal programming procedure	———	Computer	Manual	Computer, for contouring
Are sub-routines available?	———	From GE	———	From control builder
Fail-safe devices?	Yes	Yes	Yes	Yes, optional
Safe ambient temperature	Normal	Normal	55 to 105 F	50 to 110 F
Special tool preparation	Yes	Yes, presetting	Yes	Presetting
Zero offset range	Full range	Full range	100 in.	±⅛ in.
Zero shifting method	Electric clutches	Clutches	Declutch back feed	———
Service provisions	Warranty, Morton & GE	Warranty	Warranty, Natco	Warranty, by Onsrud
Training offered	Yes, by Morton	———	Yes, in Richmond	Yes, customer picks location
Normal time to learn	———	———	Two weeks	One week
Average installed cost	$1,000,000	$2,000,000 (machine only)	$95,000	$160,000
Typical job-lot size	One	One	1 to 50 pieces	1 piece up
Productivity over conventional	5 to 1	———	5 to 1	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	High pressure turbine shells	Turbine shells, hoods, marine gear cases	Normal parts from milling machines, radial drills, horiz boring mills, etc	Aircraft spars, marine parts, turbine parts, structural shapes
Additional information	Includes outside turning with 30 hp but without N/C	10 to 400 rpm speed on 3 heads, 3 to 120 rpm on boring head, both inf adj; horiz feed, 0.050 to 60 ipm, inf adj; trnas feed to 150 ipm inf adj.	Table work area, 28x40"; table travel, 24x36"; face of spindle to table, head down, 14.47"; head travel, 16"; spindle to column face, 30"; throat height, 24"	

Company name	Onsrud Machine Works, Inc	Onsrud Machine Works, Inc	Onsrud Machine Works, Inc.	Onsrud Machine Works, Inc
Address	7710 North Lehigh Ave Niles, Ill	7710 North Lehigh Ave Niles, Ill	7710 North Lehigh Ave Niles, Ill	7710 North Lehigh Ave Niles, Ill
Tradename or model number	A-245 Miller	A-2760, A-1860, MM-48 Rotary	PS-353 Router	A-9024
Type or function	Milling, profiling	Milling, profiling	Routing	Milling, profiling
Capacity	12 x 56 in.	27x60", 18x50", 48" dia table	4-10 ft wide, 40 ft long	36" wide to 150' long
Longest axis of motion	56 in.	60 in.	40 ft	To 150 ft
Spindle horsepower	10 hp	Up to 30 hp	50 hp	30 to 100 hp
Number of controlled spindles	One	1 to 3	1 or 2	Four
Minimum decimal input	0.001 in.	0.001 or 0.0001 in.	0.001 in.	0.001 or 0.0001 in.
Smallest motion increment	0.001 in.	0.001 in.	0.001 in.	0.001 or 0.0001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 or 0.0005 in.
Repeatability	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 or 0.0001 in.
Controlled motions	Three	Longitudinal, transverse, and/or vertical	Longitudinal, transverse, and/or vertical	Long, traverse, and/or vert (4 to 13 motions)
Degree of control	Contouring	Contouring	Contouring	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	———	Yes
Type of drive	Electric or hydraulic	Hydraulic and electric	Electric, Amplidyne	Electric or hydraulic
Speed range	3600 to 7200 rpm; 4 steps	12-1200, 36-7200 rpm; incr	3600 to 21,000 rpm; 4 steps	12-1200, 3600-7200 rpm; incr
Feed range	4-60 (N/C), 4-150 (man)	4 to 150 ipm; inf adj	4-200 (man), 4-60 (N/C)	4 to 150 ipm; inf adj
Control system	GE, Bendix, TRW	GE, Bendix, TRW	Bendix, GE, TRW	Bendix, GE, TRW
Manual operation?	Yes, pushbutton or manual	Yes, pushbuttons	Yes	Yes
Auxiliary functions	Cutter offset, coolant, start-stop, etc	Cutter offset, coolant, etc	Any necessary	All necessary
Automatic tool changer	No	No	No	No
Normal programming procedure	Computer for contouring	Computer, for contouring	Computer for contouring	Computer
Are sub-routines available?	———	No	———	From control builder
Fail-safe devices?	Yes, optional	Yes, optional	Yes, optional	Yes, optional
Safe ambient temperature	50 to 110 F	50 to 110 F	50 to 110 F	51 to 110 F
Special tool preparation	Presetting	Presetting	Presetting	Presetting
Zero offset range	±⅛ in.	±⅛ in.	±⅛ in.	±⅛ in.
Zero shifting method	———	———	———	———
Service provisions	Warranty, by Onsrud	Warranty, by Onsrud	Warranty, by Onsrud	Warranty, by Onsrud
Training offered	Yes, customer picks location	Yes, customer picks location	Yes, customer picks location	Yes, customer picks location
Normal time to learn	3 to 4 days	3 to 4 days	3 to 4 days	Two weeks
Average installed cost	$40,000	$65,000 to $80,000	$190,000 (for 10x40')	$550,000
Typical job-lot size	1 piece up	1 piece up	1 or more	1 or more
Productivity over conventional	———	———	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Meter parts, machine components, major appliance parts, tooling	Gear housings, motor parts, pump parts, etc	Aircraft components, structural shapes, railroad and marine equipment	Aircraft parts, railroad equipment, templets, structural shapes, marine equipment
Additional information				

N/C Selector Guide—Machines

Company name Address	Onsrud Machine Works, Inc 7710 North Lehigh Ave Niles, Ill	The Portage Machine Co 1025 Sweitzer Ave Akron 11, Ohio	Pratt & Whitney Co, Inc Charter Oak Blvd West Hartford, Conn	Pratt & Whitney Co, Inc Charter Oak Blvd West Hartford, Conn
Tradename or model number	ASI-108A Gantry Type	Model 3T Horizontal machine with 3⅜-in. bar spindle	2E and 3E Inspection Machines	4EA Universal Inspection Machine
Type or function	Skin mill	Boring, milling, drilling	Numerical inspection	Numerical inspection
Capacity	10 x 60 ft	48 x 60 x 72 in.	36x22 in.; 48x28 in.	60 x 48 x 78 in.
Longest axis of motion	60 ft	30 to 72 in.	36 in.; 48 in.	78 in. (vert)
Spindle horsepower	100 hp	7½ or 10 hp	———	Not applicable
Number of controlled spindles	Two	One	One	One
Minimum decimal input	0.001 in.	0.001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.001 in.	0.002 in.	0.0001 in.	0.0001 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.000,050 in.	Depends on no. of axes used
Repeatability	±0.001 in.	±0.0005 in.	±0.000,025 in.	±0.0002 in.
Controlled motions	Longitudinal, vertical, and transverse	Up-down, in-out, and forward-back	X and Y	X, Y, Z, Y', rotary table (2 swivel motions optional)
Degree of control	Contouring	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	No, open-loop with monitoring	Yes	Yes
Type of drive	Electric	DC motor	Motor (thyratron controlled)	Electric motors
Speed range	12-1200, 3600-7200 rpm; incr	26 to 1535 rpm; 32 steps	———	Not applicable
Feed range	4 to 150 ipm; inf adj	0.20 to 100 ipm, inf adj	0.04 to 100 ipm; inf adj (jog)	0 to 15 ipm in jog
Control system	Bendix, GE, TRW	W&S Tele-Probomat	P&W Electrolimit Numeric	P&W Electrolimit Numeric
Manual operation?	Yes, pushbuttons	Yes, pushbuttons, switches	Yes, telephone dial	Yes, telephone dial
Auxiliary functions	All machine functions	Five are standard, others optional	Any desired	Any desired
Automatic tool changer	No	No	———	Not applicable
Normal programming procedure	Computer	Manual	Manual	Manual
Are sub-routines available?	From control builder	No	Not necessary	Not needed
Fail-safe devices?	Yes, optional	Yes	Yes	Yes
Safe ambient temperature	50 to 110 F	40 to 100 F	100 F	100 F
Special tool preparation	Presetting	Yes	None	Not applicable
Zero offset range	±⅛ in.	Full range	Full range	Full range
Zero shifting method	———	Clutch	Knob adjust	Knob adjust
Service provisions	Warranty, Onsrud	Warranty, Portage	Warranty, P&W	Warranty, P&W
Training offered	Yes, customer picks location	Yes, in Akron	Yes, in West Hartford	Yes, in West Hartford
Normal time to learn	One week	2 days	Two weeks	Two weeks
Average installed cost	$750,000	$70,000	$100,000	POA
Typical job-lot size	1 or more	10 to 100	———	———
Productivity over conventional	———	100% increase	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Aircraft skins	Best for parts needing 10 to 200 min and 4 to 30 tools per part		Aircraft and missile parts
Additional information		Any part now produced manually on this type machine can be made with N/C 3T in 30 to 60% manual time. Original tool, tape, fixture, and setup cost is sometimes less, rarely over 30% of manual		

Company name Address	Pratt & Whitney Co, Inc Charter Oak Blvd West Hartford, Conn	Pratt & Whitney Co, Inc Charter Oak Road West Hartford, Conn	Pratt & Whitney Co, Inc Charter Oak Blvd West Hartford, Conn	Pratt & Whitney Co, Inc Charter Oak Blvd West Hartford, Conn
Tradename or model number	Six Coordinate Measuring Machine	Tape-O-Matic Drill, M-3042	2E Numeric Hole Grinder	Numeric Jig Borer, Models 2E, 3E, 4E, 4EA
Type or function	Numerical inspection	N/C drill	Hole grinding	Boring, drilling, milling
Capacity	0 to 24-in. dia parts	30 x 20-in. table	36 x 22 in.	36x22-in. to 60x36-in.
Longest axis of motion	20 in.	20 in.	36 in.	2E = 36 in.; 4EA = 60 in.
Spindle horsepower	———	1½ hp	Several air operated wheel heads furnished	1½ to 3 hp
Number of controlled spindles	———	One		One
Minimum decimal input	0.0001 in.	0.001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.0001 in.	0.001 in.	0.0001 in.	0.0001 in.
Normal operating accuracy	±0.0001 in.	±0.001 in.	±0.0001 in. (location)	±0.0001 in.
Repeatability	±0.000,050 in.	±0.0005 in.	±0.0001 in. (location)	±0.000,05 in.
Controlled motions	2 longitudinal, 2 vertical, rotary table, gage angle	Longitudinal and transverse	X and Y	Longitudinal, transverse, rotary, and vertical
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Electric motors	Electric motors	Motor (thyratron controlled)	Motor (thyratron controlled)
Speed range	———	150-1000, 300-2000; inf adj	4000 to 100,000 rpm; inf adj	37-1800, 30-1500 rpm; incr
Feed range	15 sec to move all slides 10"	0.004 to 0.012 ipr; 4 steps	0.0001 to 0.002 ipm; incr	0.0005 to 0.015 ipr; incr
Control system	P&W Electrolimit Control	Pratt & Whitney	P&W Electrolimit Numeric	P&W Electrolimit Numeric
Manual operation?	Yes	Yes, jogging buttons, hand	Yes, telephone dial input	Yes, telephone dial input
Auxiliary functions	Any desired	Three-digit operation readout and tool change indicator	Any desired	Any desired
Automatic tool changer	———	Optional	No	No
Normal programming procedure	Computer optional	Manual	Manual	Manual
Are sub-routines available?	———	Yes	Not needed	Not needed
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	70 F const temp control	120 F	100 F	100 F
Special tool preparation	None	None	None	None
Zero offset range	Full	Full floating	Full range	Full range
Zero shifting method	Manual shifting	Push buttons	Knob adjust	Knob adjust
Service provisions	Warranty, P&W	Warranty, P&W	Warranty, P&W	Warranty, P&W
Training offered	Yes, in West Hartford	Yes, at customer's plant	Yes, in West Hartford	Yes, in West Hartford
Normal time to learn	Four weeks	24 hours	Two weeks	Two weeks
Average installed cost	$200,000	$9,000	$81,000	$70,000 to $160,000
Typical job-lot size	1 to 10	1 to 1000 parts	1 to 50 pieces	1 to 50
Productivity over conventional	Classified jobs	3 to 1 up to 5 to 1	2 to 5 to 1	4 to 8 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Best suited for inspecting ID, OD, wall thickness of objects of revolution	All type components formerly done in single and multiple drill presses	Any holes requiring hole grinder tolerance	Any job requiring hole positioning to closer tolerances than ±0.001 in.
Additional information	Deviation of part from punched tape description is picked up by two gage heads and displayed on strip chart recorder. Makes several hundred measurements on one part and supplies record	With extremely reliable transistorized, solid-state electronic circuitry, machine is specifically designed for overall efficient operation		

Company name	Pratt & Whitney Co, Inc	Pratt & Whitney Co, Inc	Pratt & Whitney Co, Inc	The Sheffield Corp, Sub of
Address	Charter Oak Blvd West Hartford, Conn	Charter Oak Blvd West Hartford, Conn	Charter Oak Blvd West Hartford, Conn	The Bendix Corp, Box 893 Dayton 1, Ohio
Tradename or model number	30-in. vertical and 42-in. horizontal rotary tables	BL Model D Numeric Keller	K300N Numeric Keller	Model TC-101 Universal 5-Axis N/C Measuring Machine
Type or function	Rotary indexing	Most machining operations	Most machining operations	Measurement and inspection
Capacity	30 in. vert; 42 in. horiz	36 x 22 x 12-in. travels	4x2x2' to 22x8x4'	20" high x 20" dia
Longest axis of motion	Not applicable	36 in.	22 ft	20 in.
Spindle horsepower	Not applicable	15 hp	30 hp	———
Number of controlled spindles	Not applicable	1 or 3	1, 2, or 3	———
Minimum decimal input	0.0001°	0.0002 in.	0.0002 in.	0.000,010 in.
Smallest motion increment	0.0001°	0.0002 in.	0.0002 in.	0.000,010 in.
Normal operating accuracy	±5 sec arc	±0.001 in.	To be determined	.0001"; .000050 (thickness)
Repeatability	±2 sec arc	±0.0005 in.	To be determined	±0.000,005 in.
Controlled motions	Rotary	3 to 5 (X, Y, Z, Alpha, and Beta)	X, Y, Z, Alpha, and Beta	Work (rot), table (hor), styles (vert, inside; vert & hor, outs)
Degree of control	Sequencing and positioning	Contouring	Contouring	Sequencing and positioning
Type of data-input media	———	EIA std tape	EIA std tape	Bin dec 8-channel tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Motor (thyratron controlled)	Hydraulic motor	Hydraulic motor	Hydraulic
Speed range	Not applicable	40 to 3600 rpm; incr, inf adj	40 to 3600 rpm; incr	———
Feed range	0 to 2½ rpm; inf adj	0 to 180 ipm; inf adj	0 to 180 ipm; inf adj	———
Control system	P&W Electrolimit Numeric	Dynapath or Mark Century	Dynapath, Mark Century, TRW	Bendix DynaPoint 20 series
Manual operation?	Yes, telephone dial	Yes, electric switch	Yes, electric switch	Yes, knobs on control
Auxiliary functions	Any desired	Any desired	Any desired	Print out gaging data
Automatic tool changer	Not applicable	Optional	Optional	———
Normal programming procedure	Manual	Computer	Computer	Manual
Are sub-routines available?	Not needed	Yes	Yes	No
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	100 F	90 F	90 F	Not applicable
Special tool preparation	None	None	None	———
Zero offset range	Full range	Full range	Full range	20 in. on Y axis
Zero shifting method	Knob adjust	Automatic	Automatic	———
Service provisions	Warranty, P&W	Warranty, P&W	Warranty, P&W	Warranty
Training offered	Yes, in West Hartford	Yes, at P&W or customer's	Yes, at P&W or customer's	Yes, Dayton & customer's
Normal time to learn	Two weeks	One to five weeks	One to five weeks	———
Average installed cost	$30,000	$140,000	$165,000 to $275,000	$300,000 approx
Typical job-lot size	1 to 50 pieces	1 to 500 pieces	———	———
Productivity over conventional	2 to 5 to 1	4 to 8 to 1	———	———
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced		Any type parts needing milling, drilling, boring, tapping, reaming, threading, turning	Parts needing milling drilling, boring, tapping, reaming, thread milling, turning	Hemispheres, cones, tubes, and other objects of symmetry
Additional information	Designed for inspection and, in conjunction with boring machines, for indexing work			Automatically measures and records internal and external dimensions, thickness, and other geom conditions of objects of symmetry. Will print out dimensions of part of unknown size

Company name	Sundstrand Machine Tool Div	Sundstrand Machine Tool Div	Sundstrand Machine Tool Div	Sundstrand Machine Tool Div
Address	Belvidere Illinois	Belvidere Illinois	Belvidere Illinois	Belvidere Illinois
Tradename or model number	OM-3 and OM-4 Omnimils with 42, 72-in.-dia tables	Horizontal Bed-Type Machine	Model 21 Rail-Type Machine	Model 21 Heavy-Duty Rail-Type Machine
Type or function	5-axis milling, tapping, boring	3-axis milling, boring, tapping	3-axis milling, tapping, boring	3-axis milling, drilling, tap
Capacity	48, 96-in. tbl, sdl, vert stroke	24x54" table, 25" vert stroke	40x60 or 40x84" table, saddle	48x84 or 48x144", 20" vert
Longest axis of motion	48 in, 96 in.	54 in. (table stroke)	60 or 84 in.	84 or 144 in.
Spindle horsepower	25 hp, 40 hp	10 or 15 hp	10 hp	25 hp
Number of controlled spindles	Two	One	One	One
Minimum decimal input	0.0001 in.	0.0001 in.	0.0001 in.	0.0001 in.
Smallest motion increment	0.0002 in.	0.0002 in.	0.0002 in.	0.0002 in.
Normal operating accuracy	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.0003 in.	±0.0003 in.	±0.0003 in.	±0.0003 in.
Controlled motions	Table, saddle, head, table rotary, head rotary	Table (X), head vertical (Z), head cross travel (Y)	Table X axis, saddle Y axis, head vertical Z axis	Table X axis, saddle Y axis, head vertical Z axis
Degree of control	Contouring	Contouring	Contouring	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic	DC or hydraulic	DC or hydraulic	Hydraulic
Speed range	12-4000, 8-3600 incr	11 to 2000 rpm; incr	11 to 2000 rpm; incr	10 to 1640 rpm; incr
Feed range	0 to 200 ipm; inf adj	0-200 ipm; incr or inf adj	0 to 200 ipm; incr or inf adj	0 to 200 ipm; inf adj
Control system	TRW or Dynapath	TRW or Bendix	TRW or Bendix	TRW or Dynapath
Manual operation?	Yes, keyboard	Yes, keyboard	Yes, keyboard	Yes, keyboard
Auxiliary functions	Change & select tool (OM-3 only), coolant, sequence no.	Speeds, feeds, coolant, rotary table, tool change	Coolant, spindle speeds, feeds, select & tool change	Speeds, feeds, coolant, tool number
Automatic tool changer	Optional, no	Optional	Optional	No
Normal programming procedure	Computer	Computer, with contouring	Computer, with contouring	Computer
Are sub-routines available?	Yes	Yes	Yes	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F (with 90% RH)	120 F (with 90% RH)	120 F (with 90% RH)	120 F (with 90% RH)
Special tool preparation	Yes	Yes	Yes	None
Zero offset range	Full range	Full range	Full range	Full range
Zero shifting method	Dial, calib to 0.0001 in.	Dial	Dial	Dial
Service provisions	Warranty, Sundstrand	Warranty, Sundstrand	Warranty, Sundstrand	Warranty, Sundstrand
Training offered	Yes, in Belvidere	Yes, in Belvidere	Yes, in Belvidere	Yes, in Belvidere
Normal time to learn	Two weeks	Two weeks	Two weeks	Two weeks
Average installed cost	———	———	———	———
Typical job-lot size	1 to 50 pieces	1 to 50 pieces	1 to 50 pieces	1 to 50 pieces
Productivity over conventional	70% time reduction & more	70% time reduction	70% time reduction	70% time reduction
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Complex parts needing angular or compound angular machining	Square or round parts needing work on 4 or 8 sides in one setup, as pump bodies	Flat work such as covers, vending machine frames, and templets	CI and high tensile steel parts such as die blocks and templets
Additional information	Can machine hemisphere and drill holes anywhere on it. Feedbacks give rotary posit to ±8 sec abs, ±4 sec repeatably on OM-3. 60-tool changer on OM-3 has key coding	Full hp available down to 100 rpm. Equipped with 24-in. dia rotary table normally 8-posit index, but can be provided with 4th axis. 20-tool changer with keyed collet spindle drive is available	Equipped with automatic 20-tool changer and keyed collet spindle drive. Full 10 hp available down to 100 rpm. Sundstrand has available simplified computer programming system	Full 25 hp available down to 100 rpm. Power operated draw bar provided. Sundstrand has available a simplified computer program for this machine

N/C Selector Guide—Machines

Company name	Sundstrand Machine Tool Div	Sundstrand Machine Tool Div	The Thompson Grinder Co	Wadkin Ltd
Address	Belvidere Illinois	Belvidere Illinois	1534 W Main St Springfield, Ohio	Green Lane Works Leicester, England
Tradename or model number	14 NC Lathe	15 NC Turret Lathe	Type C Tapeforming Continuous Path Grinder	TCD 2
Type or function	Shaft-type turning	Chucker-type turning	Contour grinding	Condenser plate drilling
Capacity	23-in. dia swing	36-in. dia swing	14x28x60-in. workpiece	14 x 20 ft
Longest axis of motion	60 in. or greater	24 in. or greater	60 in.	20 ft
Spindle horsepower	50 hp	50 hp	5 hp	30 hp
Number of controlled spindles	One	One	One	Four
Minimum decimal input	0.0001 in.	0.0001 in.	0.0002 in.	0.001 in.
Smallest motion increment	0.0002 in.	0.0002 in.	0.0002 in.	0.0005 in.
Normal operating accuracy	±0.0005 in./ft	±0.0005 in./ft	±0.0001 in.	±0.0005 in./ft
Repeatability	±0.0003 in.	±0.0003 in.	±0.0002 in.	±0.001 in.
Controlled motions	Cross and longitudinal	Cross and longitudinal	Table and wheel head	Drill unit in both axes
Degree of control	Contouring	Contouring	Contouring	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape, BCD 8-chan tape	Punched 4-in. plastic tape
Feedback?	Yes	Yes	Yes (can operate open loop)	No
Type of drive	Hydraulic	Hydraulic	Hydraulic	Motors and mag clutches
Speed range	124 to 1900 rpm; incr	124 to 1900 rpm; incr	0 to 150 ipm	———
Feed range	0 to 30 ipm; inf adj	0 to 30 ipm; inf adj	0.0002 to 0.004; 0.0002 steps	60 ipm; 3 ipm steps (posit)
Control system	TRW, GE, Dynapath	GE, TRW, Dynapath	TRW, Dage	Airmec, High Wycombe, Eng
Manual operation?	Yes, keyboard	Yes, keyboard	Yes, on elevation, handwheel	Yes, dials and pushbuttons
Auxiliary functions	Speed & feed selection, coolant, turret position	Speed & feed selection, coolant, turret position	Dressing cycle and compensation, others	Tapping and reaming
Automatic tool changer	No	No	No	No
Normal programming procedure	Manual	Manual	Computer	Manual
Are sub-routines available?	Yes	Yes	Yes	———
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	120 F (with 90% RH)	120 F (with 90% RH)	95 F	100 F
Special tool preparation	Yes	Yes	None	Yes
Zero offset range	Full range	Full range	½ in.	20 ft
Zero shifting method	Dial	Dial	Manual	Mechanical
Service provisions	Warranty, Sundstrand	Warranty, Sundstrand	Warranty, TG & system mfr	Warranty, Wadkin
Training offered	Yes, in Belvidere	Yes, in Belvidere	Yes, TRW & customer's plant	Yes, on site
Normal time to learn	Two weeks	Two weeks	Two weeks	7 days
Average installed cost	———	———	$75,000	$140,000
Typical job-lot size	1 to 50 pieces	1 to 50 pieces	One or more	1 to 24 pieces
Productivity over conventional	70% time reduction	70% time reduction	———	4 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	All shaft-type parts with radii, contours, tapers	Boring, facing & turning of chucker-type parts with 2-axis contouring	Airfoil forms, non-cavity-type dies or punches, templets, molds	Drilling large condenser plates up to 20 x 14 ft
Additional information	Designed for full production at full hp. Features rugged beds, high hp, hardened way surfaces with only roller contact between slides and ways. Can take multiple cuts, sometimes eliminate forgings	Designed for full production at full hp. Features rugged beds, high hp, hardened way surfaces with only roller contact between slides and ways	Speed in incr on transverse, inf adj on long and vert. Control on wheel spindle motor automatically changes spindle speed from dresser position to keep constant peripheral speed of wheel	

Company name	Wadkin Ltd	Warner & Swasey Co	Warner & Swasey Co	The Warner & Swasey Co
Address	Green Land Works Leicester, England	5701 Carnegie Ave Cleveland 3, Ohio	5701 Carnegie Ave Cleveland 3, Ohio	5701 Carnegie Ave Cleveland 3, Ohio
Tradename or model number	TCD1	M-3030 1AC Single Spindle Chucking Automatic	M-3200 2AC Single Spindle Chucking Automatic	M-3380 2AB Single Spindle Bar Automatic
Type or function	Drilling machine	Turning	Turning	Turning
Capacity	60 x 36-in. table	8 or 10-in. chuck	10 or 12-in. chuck	3-in. bar capacity
Longest axis of motion	60 in.	7¼ in.	11 in.	11 in.
Spindle horsepower	5 hp	15 hp	25 hp	25 hp
Number of controlled spindles	One	One	One	One
Minimum decimal input	0.001 in.	———	———	———
Smallest motion increment	0.0005 in.	———	———	———
Normal operating accuracy	±0.002 in.	±0.001 in.	±0.001 in.	±0.001 in.
Repeatability	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 in.
Controlled motions	Table and drill head	Longitudinal and cross	Longitudinal and cross	Longitudinal and cross
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Positioning
Type of data-input media	Punched 4-in. plastic tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	No	No	No	No
Type of drive	Motors and mag clutches	Motors, gears, and cams	Motors, gears, and cams	Motors, gears, cams
Speed range	———	56 to 1524 rpm; incr	38 to 1058 rpm; incr	56 to 1544 rpm; incr
Feed range	60 ipm; 3 ipm steps (posit)	0.0019 to 0.124 ipm; incr	0.0019 to 0.124 ipm; incr	0.0019 to 0.124 ipm; incr
Control system	Airmec, High Wycombe, Eng	Wang Laboratories	Wang Laboratories	Wang Laboratories
Manual operation?	Yes, dials and pushbuttons	Yes, switches, pushbuttons	Yes, switches, pushbuttons	Yes, switches, pushbuttons
Auxiliary functions	Tapping and reaming	Coolant, index, feed change, speed change	Coolant, index, feed and speed change, etc	Coolant, index, speed and feed changes
Automatic tool changer	Optional	No	No	No
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	———	———	———
Fail-safe devices?	Yes	———	Yes	Yes
Safe ambient temperature	100 F	130 to 150 F	130 to 150 F	130 to 150 F
Special tool preparation	Yes	None	None	None
Zero offset range	0 to 60 in.	Not offered	Not offered	Not offered
Zero shifting method	Mechanical	———	———	———
Service provisions	1-yr warranty, Wadkin	Warranty, W&S	Warranty, W&S	Warranty, W&S
Training offered	If wanted, in Leicester	Yes, customer's plant	Yes, at customer's plant	Yes, at customer's plant
Normal time to learn	Three days	———	———	———
Average installed cost	$40,000	$31,310	$36,505	$43,010
Typical job-lot size	1 to 50	25 piece minimum	25-piece minimum	25-piece minimum
Productivity over conventional	4 to 1 in some cases	2 up to 10 to 1	2 up to 10 to 1	2 to 10 to 1
Designed for N/C?	Specifically	Adapted	Adapted	Adapted
Typical parts produced	Drilling general machine parts up to 60x36x36" deep, with holes up to 2" dia	Shafts, housings, bearings, gears, other parts needing fine finish, accurate threads	See M-3030 1AC	See M-3030 1AC
Additional information		Readily convertible between tape and standard operation; thus immediate operation upon machine installation. All machine functions are under tape command		

Company name Address	Warner & Swasey Co 5701 Carnegie Ave Cleveland 3, Ohio	The Warner & Swasey Co 5701 Carnegie Ave Cleveland 3, Ohio	Wiedemann Machine Co Gulph Rd King of Prussia, Pa	Wiedemann Machine Co Gulph Rd King of Prussia, Pa
Tradename or model number	M-3250 3AC Single Spindle Chucking Automatic	SCA-25 N/C Turret Lathe	Wiedematic Type A15-3048 and A15-3072	Wiedematic Type A50-4860 and A50-4896
Type or function	15 or 18-in. chuck	Contour turning	Turret press and gage	Turret press and gage
Capacity	13 in.	25-in. swing over bed	15 ton, 30x48, 30x72"	50 ton, 48 x 60, 48 x 96 in.
Longest axis of motion	40 hp	51 in.	48 in.; 72 in.	60 in., 96 in.
Spindle horsepower	One	60 hp	45 hp	154 hp
Number of controlled spindles		One	One (punch ram)	One (punch ram)
Minimum decimal input	———	———	0.001 in.	0.001 in.
Smallest motion increment	———	0.0005 in.	0.002 in.	0.002 in.
Normal operating accuracy	±0.001 in.	±0.0005 in.	±0.004 in.	±0.008 in.
Repeatability	±0.001 in.	±0.0005 in.	±0.002 in.	±0.004 in.
Controlled motions	Longitudinal and cross	Simultaneous control of cross slide and main tool slide	Table motions, turret rotation, and punch stroke	Table motions, turret rotation, and punch stroke
Degree of control	Sequencing and positioning	Contouring	Sequencing and positioning	Sequencing and positioning
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	No	Yes	Yes	Yes
Type of drive	Motors, gears, and cams	Electric servo motors	Hydraulic pistons, motors	Hydraulic pistons, motors
Speed range	30 to 826 rpm; incr	12 to 851 rpm; incr	600 ipm (table), 10 rpm (tur)	600 ipm (table), 10 rpm (tur)
Feed range	0.0019 to 0.124 ipm; incr	0.001 to 0.030 ipm; incr	15/16-in. punch stroke	1½-in. punch stroke
Control system	Wang Laboratories	Warner & Swasey Co	GE Mark II, Sperry, Prodac	GE Mark II, Sperry, Prodac
Manual operation?	Yes, switches, pushbuttons	Yes, dial & joy stick levers	No	No
Auxiliary functions	Coolant, index, speed and feed change, etc	———	Position-no punch, operator instruction, cycle complete	Position-no punch, operator instruction, cycle complete
Automatic tool changer	No	No	Not required	Not required
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	———	Yes	No	No
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	130 to 150 F	100 F	100 F	100 F
Special tool preparation	None	None	None	None
Zero offset range	Not offered	Not offered	0.200 in.	0.200 in.
Zero shifting method	———	———	Electric	Electric
Service provisions	Warranty, Warner & Swasey	———	Warranty, Wiedemann, cntr mfr	Warranty, Wiedemann, cntr mf
Training offered	Yes, at customer's plant	———	Yes, at Wiedemann & cntr mfr	Yes, at Wiedemann & cntr mfr
Normal time to learn	———	———	Two weeks	Two weeks
Average installed cost	$45,435	———	———	———
Typical job-lot size	25-piece minimum	———	1 to 750 pieces	1 to 500 pieces
Productivity over conventional	2 up to 10 to 1	———	2½ to 5 times	2½ to 5 times
Designed for N/C?	Adapted	Specifically	Specifically	Specifically
Typical parts produced	See M-3030 1AC	Any part as same size conventional machine, plus accurate contours	Thin sheet metal products up to 3/16-in. thick punched with variety of holes	Sheet metal products up to ¼-in. thick pierced with variety of holes
Additional information			Control provided with manual data input by pushbutton or dial selection of dimensional data. 26 to 36 tool stations are available in turrets	Control provided with manual data input by pushbutton or dial selection of dimensional data. 26 to 36 tool stations are available in turrets

Company name Address	Wiedemann Machine Co Gulph Rd King of Prussia, Pa	Wiedemann Machine Co Gulph Rd King of Prussia, Pa	Wiedemann Machine Co Gulph Rd King of Prussia, Pa	Young Electronic Testing Corp Church Rd, Box 233 Bridgeport, Pa
Tradename or model number	Wiedematic Type A30-3660, A30-4860, and A30-4896	Wiedematic Type A100-60100 and A100-60120	Wiedematic Type A150-72120	Young Model 125-T Tape Controlled Turret Drill
Type or function	Turret press and gage	Turret press and gage	Turret press and gage	Contour turning
Capacity	30 ton, 36x60, 48x60, 48x96"	100 ton, 60 x 100, 60 x 120"	150 ton, 72 x 120-in. table	1¼-in. drill & tap
Longest axis of motion	60 in., 96 in.	in. 100 in., 120 in.	120 in.	52 in.
Spindle horsepower	119 hp	317 hp	500 hp	10 hp
Number of controlled spindles	One (punch ram)	One (punch ram)	One (punch ram)	Eight
Minimum decimal input	0.001 in.	0.001 in.	0.005 in.	0.001 in.
Smallest motion increment	0.002 in.	0.002 in.	0.005 in.	0.0005 in.
Normal operating accuracy	±0.006 in.	±0.010 in.	±0.012 in.	±0.001 in.
Repeatability	±0.003 in.	±0.005 in.	±0.006 in.	±0.0005 in.
Controlled motions	Table motions, turret rotation, and punch stroke	Table motions, turret rotation, and punch stroke	Table motions, turret rotation, and punch stroke	X and Y axes, and Young Precision Depth Control
Degree of control	Sequencing and positioning	Sequencing and positioning	Sequencing and positioning	Contouring
Type of data-input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Feedback?	Yes	Yes	Yes	Yes
Type of drive	Hydraulic pistons, motors	Hydraulic	Hydraulic	Direct
Speed range	600 ipm (table), 10 rpm (tur)	600 ipm (table), 10 rpm (tur)	400 ipm (table), 10 rpm (tur)	100 to 3000 rpm; incr
Feed range	1¼-in. punch stroke	2-in. punch stroke	2½-in. punch stroke	0 to 50 ipm; inf adj
Control system	GE MARK II, Sperry, Prodac	GE Mark II, Sperry, Prodac	GE Mark II, Sperry, Prodac	GE Mark II
Manual operation?	No	No	No	Yes, with jog buttons
Auxiliary functions	Position-no punch, operator instructions, cycle complete	Position-no punch, operator instruction, cycle complete	Position—no punch, operator instruction, cycle complete	Coolant on/off, turret and spindle selection
Automatic tool changer	Not required	Not required	Not required	———
Normal programming procedure	Manual	Manual	Manual	Manual
Are sub-routines available?	No	No	No	Yes
Fail-safe devices?	Yes	Yes	Yes	Yes
Safe ambient temperature	100 F	100 F	100 F	70 F
Special tool preparation	None	None	None	To suit customer
Zero offset range	0.200 in.	0.200 in.	0.200 in.	0.100 in.
Zero shifting method	Electric	Electric	Electric	Dial
Service provisions	Warranty, Wiedemann, cntr mfr	Warranty, Wiedemann, cntr mfr	Warranty, Wiedemann, cntr mfr	1-yr warranty, Young
Training offered	Yes, at Wiedemann & cntr mfr	Yes, at Wiedemann & cntr mfr	Yes, at Wiedemann & cntr mfr	Yes, at customer's plant
Normal time to learn	Two weeks	Two weeks	Two weeks	2 days to 1 week
Average installed cost	———	———	———	$58,000
Typical job-lot size	1 to 750 pieces	1 to 500 pieces	1 to 250 pieces	———
Productivity over conventional	2½ to 5 times	2½ to 5 times	2½ to 5 times	6 to 1
Designed for N/C?	Specifically	Specifically	Specifically	Specifically
Typical parts produced	Sheet metal products up to ¼-in. thick pierced with variety of holes	Sheet metal products up to ⅜-in. thick pierced with variety of holes	Sheet metal products up to ½-in. thick pierced with variety of holes	———
Additional information	Control provided with manual data input by pushbutton or dial selection of dimensional data. 26 to 36 tool stations are available in turrets	Control provided with manual data input by pushbutton or dial selection of dimensional data. 26 to 36 tool stations are available in turrets	Control provided with manual data input by pushbutton or dial selection of dimensional data. 26 to 36 tool stations are available in turrets	Milling features, tapered shank or milling-type spindles, coolant or spray mist through spindles, spindle reverse features, turret indexing clockwise or counterclockwise

N/C Selector Guide—Systems

Company name **Address** **Tradename or model number**	Allen-Bradley Co 136 W Greenfield Ave Milwaukee 4, Wis Allen-Bradley N/C	American SIP Corp 100 E 42nd St New York 17, NY CN-4	Auerbach Electronics Corp 1634 Arch St Philadelphia 3, Pa Custom built for application	Barber-Colman Co 1300 Rock St Rockford, Ill Tape-R-Guide
Control function **Control type** **Number of controlled axes**	——— Absolute, closed loop 1 to 5, simultaneously	Positioning Absolute, closed loop 3, 2 simultaneously	Sequence, position Digital, increm, closed loop One	Sequence, position, contour Digital, increm, open loop Two, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dial Manual Word address (tab seq later) Transducer	EIA std tape Yes, pushbutton & optics Manual Straight binary Optics	5-channel tape, special code Yes, switches Computer Straight binary Rack, photoelectric digitizer	EIA std tape No Manual Variable block Leadscrew
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.0001 in. ±0.000,01 in. ±0.0005 in. ±0.0002-3 in. ——— 0.025 in. Synchro	0.0001 in. ±0.000,004 in. ±0.000,075 in. ±0.000,040 in. 0.000,075 in. ±2 in. Mechanical	1/512 in. ±1/512 in. ±1/64 in. ——— 1/64 in. Not offered ———	0.001 in. ±0.001 in. ——— ——— 0.001 in. Not required ———
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	DC motor, hydraulic DC to 15 hp; 150 hp with MG 1 to 5 Depends on requirements 150 ipm 4.6 sec (2 ax); + .6 sec/ax	Hydraulic, electro-mechanical 1 hp Three 51 in. (to date) 100 ipm (hydraulic) 20 sec	Hydraulic piston (to date) ——— One 64 in. with present system 120 in./sec 1 sec per operation	Variable speed DC motors 15 hp Two 54 in. 45 ipm, 1 drive 17.2 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	10 non-persistent, 10 to 30 persistent Yes Tool number ———	Spindle feed and speed, control rotary table No Input data, tool number ———	Tool selection Yes Input, acti posit, tool no. ———	Spindle speeds & stop, feed rates, coolant on/off No Tool number ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Hermetically-sealed switches Modular construction Parity check and others Yes, by Allen-Bradley Milwaukee or installation Program, operation, maint $6,000 per axis	Transistor Modular construction See addl information Yes, by AmerSIP New York City Maintenance only $34,000	Transistor & relays Modular construction ——— No ——— ——— $30,000	Transistor, magnetics & relays Modular construction None Yes, by Barber-Colman Rockford All phases $43,000 (includes lathe)
Most suitable applications **Additional information**	Drilling, reaming, tapping, boring, spot facing & milling, bending, forming, assembly Input data display optional, actual position display available at extra cost. Circuit construction also includes some solid-state devices	Designed for SIP Hydroptic 6A and 7A If table or head is not in position, the vertical spindle motion is cancelled	Special purpose system, current applications confidential	Control was designed for B-C's Tape-R-Guide lathe, and is only application Tape punch includes dec to bin transiator for better reliability. No storage of info necessary at machine. Tape reader is used as rev counter and feed distance is determined by feed rate selected and number of tape feed holes. Spindle feed or speed changeable without stopping

Company name **Address** **Tradename or model number**	Bendix Indust Controls Sec 21820 Wyoming Ave Detroit 37, Mich DynaPoint 20	Bendix Indust Controls Sec 21820 Wyoming Ave Detroit 37, Mich DyanPath-20	Carlton Controls Corp 15 Sagamore Rd Worcester 5, Mass Model 600	Centre Circuits Inc State College Pennsylvania Centrepoint
Control function **Control type** **Number of controlled axes**	Positioning Digital, absol, closed loop 2 to 5, 2 simultaneously	Contouring Digital, increm closed loop Two to five, simultaneously	Sequence, position Digital, absol, closed loop Any number, simultaneously	Sequencing, positioning Digital, absol, open loop 2, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dials Manual BCD (word address) Leadscrew, rack, transducer	EIA std tape Yes, dial, pushbutton, poten Manual or computer BCD (word address); str bin Leadscrew, rack, transducer	EIA std tape Yes, serial entry, keyboard ——— BCD (word address) Leadscrew, rack	EIA std tape Yes, dial Manual BCD Fixed gage bar
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.000,01 in. ±0.001 to ±0.000,010 in. Same Same None Full range Dial	0.000,020 in. ±0.0002 to ±0.000,020 in. Same Same None Full range Dial	0.001 in. ±0.001 in. ±0.001 in. ±0.0002 in. 0.001 in. Full range Manual, remote clutch	0.001 in. ±0.001 in. ±0.001 in. ±0.0003 in. None 1 in. Manual
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Hydraulic & Electric No limit (10 hp to date) 2 to 5 No limit 60 to 200 ipm Depends on application	Hydraulic and electric No limit (10 hp to date) Two to five No limit ——— Not limited by control	All types No limit Any number 1000 in. 150 ipm 7 sec	Elec motor 1/3 hp (or others) 2 drives per axis 24 in. (ltd by gage bar) 175 ipm 6 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Stop, drilling, milling, tapping, boring sequences Yes Input data, tool number ———	Program stop, end of tape (rewind), reference point Yes Command posit, tool number Linear, circular; internal	Four-function flip flop, 1 in 10, any quantity Yes Input, acti posit, tool no. Linear	Auto head feed, 4-step rot index, coolant, auto clamp No None ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Transistor Modular construction Parity-transfer Yes, by Bendix Coast-to-coast All phases Machine builder responsible	Transistor Modular construction Built-in op test; parity trans Yes, by Bendix Coast-to-coast All phases Machine builder responsible	Elec tube & transistor Modular construction Positive closed loop Yes, by Carlton Worcester All phases $14,000	Air-electric Swingout panels Fail-safe design, pos ref Customer should maintain after adequate training All phases (1 week course) $11,000 to $12,000
Most suitable applications **Additional information**	Drilling, tapping, boring, and combination machine plus special milling	Milling, turning, boring, and other machining operations	Drilling, boring, welding, soldering, photogrammetry, small parts inspection, etc Carlton offer a complete listing of optional accessories including line of positioning tables and readout systems, either direct or remote	Retrofitting drilling, spotfacing, and other standard shop equipment Pneumatic block reader reads X, Y, and addl info simultaneously; maintenance simplified, since no electronics; machine tool retains manual capability after retrofit. Control designed so that machine doesn't loose reference after air or elec failure

Company name **Address** **Tradename or model number**	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic Simplified Posit	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic Simul Positioner	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic for Turret Drill	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic Rate Controlled
Control function **Control type** **Number of controlled axes**	Positioning Analog, absol, closed loop 2, not simultaneously	Positioning Analog, absol, closed loop 2, simultaneously	Positioning Analog, absol, closed loop 3, simultaneously	Positioning Analog, absol, closed loop 2, not simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, decade switches Manual Tab sequential Rack	EIA std tape Yes, decade switches Manual Tab sequential Leadscrew, rack	EIA std tape Yes, decade switches Manual Tab sequential Leadscrew	EIA std tape Yes, dial Manual Tab sequential Leadscrew, rack
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.0005 in. ±0.0002 in. ±0.001 in. ±0.002 in./ft ±0.050 in. Mechanical shift of feedback	0.001 in. ±0.000,05 in. ±0.001 in. ±0.0002 in. Depends on screw or rack Full range Electronic	0.001 in. ±0.000,05 in. ±0.001 in. ±0.0002 in. Depends on screw or rack Full range Electronic	0.001 in. ±0.000,05 in. ±0.001 in. ±0.0002 in. Depends on screw or rack Full range Electronic
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Cylinder drive only ⅛ hp 2 39.999 in. 140 ipm; 2 drives 12 sec	Hydraulic motor Unlimited Up to 5 999.999 in. Unlimited Not more than 4 sec	Hydraulic motor Unlimited Up to 5 999.999 in. Unlimited Not more than 4 sec	Hydraulic motor Unlimited Up to 5 999.999 in. Unlimited Not more than 4 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Op no. readout, coolant on/off, tool change, drill-tap No None ———	Various readouts, tool chg, stop, feed, speed, tap cycle Yes Input data ———	Various readouts, Z work plane Yes Input data ———	Extra digit input, various readouts Yes Input data ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Elec tube, switching Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $9,000	Elec tube, switching Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $14,000	Elec tube, switching Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $19,000	Elec tube, switching Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $16,000
Most suitable applications	Sliding head drills	Heaidrill, built by Heald Machine Co, Worcester, Mass	Turret drills	Lathes and milling machines
Additional information				

Company name **Address** **Tradename or model number**	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic Contouring System	Cimtrol Div, CMMCo 4701 Marburg Ave Cincinnati 9, Ohio Acramatic Ultra-Prec Contour	Cutler-Hammer, Inc 315 N 12th St Milwaukee 1, Wisc ———	DeVlieg Machine Co Fair St Royal Oak, Mich Diatrol and Tapac III
Control function **Control type** **Number of controlled axes**	Contouring Analog, absol, closed loop 3, simultaneously	Contouring Analog, absol, closed loop 3, simultaneously	Sequencing, positioning Digital, closed loop 2, simultaneously	Sequencing and positioning Analog, absol, op & clsd loop 2 + 1 aux, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape, punched cards Yes, dials or decade switches Manual and computer Tab sequential Leadscrew	EIA std tape or punched Yes, dials or decade switches Manual and computer Tab sequential Leadscrew, rack	EIA std tape Yes, dial Manual ——— Ldscrew resolver, Inductosyn	EIA std tape Yes, dial Manual Tab sequential Diatrol Measuring System
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.000,05 in. ±0.0003 in. ±0.0001 in. Depends on screw or rack Full range Electronic	0.000,01 in. ±0.000,005 in. ±0.000,03 in. ±0.000,01 in. Depends on screw or rack Full range, Electronic	Special systems built to suit requirements of each job	0.0001 in. ±0.0001 in. ±0.0001 in./ft. ±0.0001 in. ±0.0001 in./ft. Full range Manual
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Hydraulic motor Unlimited Up to 5 999.999 in. Unlimited Depends on drive system	Hydraulic motor Unlimited Up to 5 99.9999 in. Unlimited Depends on drive system		——— ——— ——— 144 in. 150 ipm 10 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Cutter compensation, on/off, extra digit input, readouts Yes Actual position Linear, parabolic	Cutter compensation, on/off, extra digit input, readouts Yes Actual position Linear, parabolic	Yes	Feeds, speeds, coolant, platen retract, depth, cycles Yes, if provided Actual position, tool number ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Elec tube, transistors, switches Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $58,000	Elec tube, transistors, switches Modular construction Diagnostics by module Yes, by Cimtrol Cincinnati All phases $64,000	Transistor Modular construction ——— Yes, by Cutler-Hammer Milwaukee & New York Prog, operation, maint ———	Transistor Modular construction Posit, inch, dec settings Yes, by DeVlieg Royal Oak, Hartford, Conn, LA All phases $30,000 to $50,000
Most suitable applications	Profilers, skin mills, die sinkers	Boring machines, precision profilers	Applications involving NPC and after gaging as one system	Precision parts, printing press side frames, textile machines, jigs and fixtures, etc
Additional information				System designed exclusively for use on Sipramatic Jig-mils, and is integral with machine control. Main machine functions are sequenced electrically, do not require special programming. Two axes are on tape, one is pre-programmed.

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Company name Address Tradename or model number	Diehl Manufacturing Co Finderne Plant Somerville, NJ Singer	Diehl Manufacturing Co Finderne Plant Somerville, NJ Singer	Diehl Manufacturing Co Finderne Plant Somerville, NJ Singer	Farrand Controls Inc 99 Wall St Valhalla, NY Inductosyn N/C System
Control function Control type Number of controlled axes	Positioning Analog, increm, closed loop Two, simultaneously	Positioning Analog, incremental 2, simultaneously	Positioning Analog, incremental 2, simultaneously	Positioning, contouring Analog, absol, closed loop Up to 3, 2 simultaneously
Input media Manual input possible? Programming method Information coding method Basic measuring system	EIA std tape Yes, dial optional Manual Fixed sequential Pin bar & micrometer servo	EIA std tape Yes, dial Manual Fixed seq, dial input Pin bar & micrometer	EIA std tape Yes, dial optional Manual Fixed sequential Pin bar & micrometer servo	EIA std tape Yes, decimal rotary switches Manual Tab sequential Direct-measuring inductosyn
Smallest input increment Normal system resolution Recommended accuracy range Repeatability Maximum cumulative error Zero offset range Zero shifting method	0.0001 in. ±0.0001 in. ±0.0005 in. ±0.0002 in. 0.001 in. 1 in. Micrometer	0.001 in. ±0.001 in. ±0.0005 in. ±0.0005 in. 0.001 in. 1 in. Micrometer	0.0001 in. ±0.000,025 in. ±0.0002 in. ±0.0001 in. 0.0002 in. 1 in. Micrometer	0.000,01" or 0.36 sec of arc Same as input ±0.0001"; ±2 sec of arc ±0.000,02" ±0.1 sec of arc None Full range ———
Types of drives controllable Maximum drive power Number of drives controlled Longest practical motion Maximum positioning feed rate Time to move all axes 10 in.	AC servo motors 400 watts As required 40 in. 60 ipm 14 sec	AC servo 200 watts Two 99 in. 135 ipm 12 sec	AC servo motor 400 watts Two 40 in. 60 ipm 16 sec	Hyd, amplid, mag amp, thyra Unlimited Up to 3 Approximately 200 in. Up to 150 ipm or 1 rpm Usually 2 sec
Standard auxiliary functions Will it control tool changer? Type of visual display Type of data interpolation	Automatic spindle command as required Yes Input data ———	As required Yes Input data, tool number ———	Automatic clamping, spindle, etc Yes Input data ———	Up to 5 on/off functions available Yes Input, std, others optional Spline, for contouring
Basic circuit construction Maintenance considerations Self-checking capability Maintenance service provided? How many locations? Training offered? Average installed cost	Elec tube, transistor Modular construction ——— Yes, by Diehl Somerville All phases $8500 (system only)	Elec tube or transistor Modular construction On request Yes, by Diehl Somerville All phases Less than $10,000	Elec tube & transistor Modular construction ——— Yes, by Diehl Somerville All phases Less than $15,000	Transistor Modular construction Tape error, sequence, analog Yes, by Farrand Controls Valhalla Prog, operation, maint $16,000 to $18,000 (2 axis)
Most suitable applications Additional information	Spacer Table Control package designed for layout work; table has 1000-lb capacity	Any small-lot-quantity operation where point-to-point machine required	Designed for operation of jig borers with 20 x 40 in. field of operation	Borers, jig borers, mills, drill presses, welders, rotary tables, lathes, grinders Rotary systems come with dec or deg & sec input. Triple Inductosyn, which contains coarse, medium, and fine patterns in 1 direct element, reduces need for high accuracy screws or racks. It allows use of direct power drive without auxiliary data

Company name Address Tradename or model number	Farrand Controls, Inc 99 Wall St Valhalla, NY Simplified Manual Input Sys	Ferranti Electric, Inc Industrial Park No. 1 Plainview, NY FNP Numerical Positioning Sys	Ferranti Electric, Inc Industrial Park No. 1 Plainview, NY Transistor/Hydraulic CP Cntl	Fosdick Machine Tool Co 1638 Blue Rock St Cincinnati 23, Ohio Fosmatic
Control function Control type Number of controlled axes	Positioning, measuring Analog, absol, open loop 2, simultaneously	Sequencing, positioning Digital, absol, closed loop 2, simultaneously	Sequence, position, contour Digital, absol, closed loop 3, simultaneously	Positioning Digital, absol, open loop 4, not simultaneously
Input media Manual input possible? Programming method Information coding method Basic measuring system	No tape input Yes, decimal rotary switches ——— ——— Direct measuring inductosyn	EIA std tape Yes, dials Manual Straight binary Diffraction grating system	Ferranti 5-hole code Yes, pushbutton Computer Straight binary Diffraction grating system	EIA std tape Yes, dials Manual Binary coded decimal Gages
Smallest input increment Normal system resolution Recommended accuracy range Repeatability Maximum cumulative error Zero offset range Zero shifting method	0.000,01" or 0.36 sec of arc Same as input ±0.0001"; ±2 sec of arc ±0.000,01"; ±0.2 sec arc None Full range ———	0.000,25 in. ±0.00025 in. ±0.00025"; ±0.0002 in./ft ±0.0002 in. None Unlimited ———	0.0002 in. ±0.0002 in. ±0.0002 in., ±0.0002 in./ft ±0.0002 in. None Unlimited Pushbutton	0.0001 in. ——— ±0.0001 in. ±0.0001 in. ——— 1/3 of travel Mech manual
Types of drives controllable Maximum drive power Number of drives controlled Longest practical motion Maximum positioning feed rate Time to move all axes 10 in.	——— ——— Approximately 200 in. ——— Depends on operator	Elec motor, hyd motors, rams 3 hp 2 10 ft 200 ipm Approximately 4 sec	Hyd gear box & rams 3 hp 3 42 ft 15 to 150 ipm (dep on resol) ———	Any drive with posit speed No limit ——— ——— Approx ½ ipm ———
Standard auxiliary functions Will it control tool changer? Type of visual display Type of data interpolation	None No Input data ———	Spindle and coolant on/off, turret selection Yes Actual posit, tool number Linear	Spindle and coolant on/off, automatic datum Yes ——— Parabolic, circular	Coolant, modes of operation Yes Input data, tool number Linear
Basic circuit construction Maintenance considerations Self-checking capability Maintenance service provided? How many locations? Training offered? Average installed cost	Transistor Modular construction None Yes, by Farrand Controls Valhalla Operation, maintenance $2500 (1 axis); $4500 (2)	Transistor Modular construction Ternary checking circuits Yes, by Ferranti New York, Detroit All phases $12,000, with drives	Transistor Modular construction Check channel on mag tape Yes, by Ferranti New York, Detroit All phases $40,000, with drives	Relay Modular construction ——— Yes, by Fosdick Cincinnati All phases $17,500 to $25,000
Most suitable applications Additional information	Measuring, positioning, improving accuracy of machines dependent on screw Designed for retrofit of gage rod jigborers to increase production and maintain accuracy. Easily retrofitted to all machines	Automatic drilling, tapping, reaming, c'boring with multi-spindle or turret drill	General machining of components with contours, varying height locations, etc	Fosmatic Jig Borer System is not sold as a package system, but is incorporated in design of the Fosmatic Jig Borers and Jig Grinders

Company name **Address** **Tradename or model number**	General Electric Co Waynesboro Virginia Mark Series Positioning Contr	General Electric Co Waynesboro Virginia Mark Century Positioning	General Electric Co Waynesboro Virginia Magnetic Tape Contouring	General Electric Co Waynesboro Virginia Mark Century Contouring
Control function **Control type** **Number of controlled axes**	Positioning Analog, absol, closed loop 1 to 5, simultaneously	Positioning Digital, absol, closed loop 1 to 5, simultaneously	Contouring Analog, increm, closed loop 2 to 5, simultaneously	Contouring Digital, increm, closed loop 2 to 5, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, digit buttons Manual or computer Tab seq, word address Optional	EIA std tape Yes, dials Manual or computer Tab seq, word address Optional	Magnetic tape No Comptuer See addl info Leadscrew or rack	EIA std tape Yes, digit switches Manual, computer Tab seq, word address Optional
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.001 in. ±0.0002 to 0.001 in. ±0.0001 to 0.0005 in. ——— ±0.020" (std), full (opt) Electric	0.0001 in. ±0.0001 in. ±0.0002 to 0.001 in. ±0.0001 to 0.0005 in. ——— Full Electric	Function of computer Not applicable Function of machine tool Function of machine tool None Full range Differential synchro	0.0001 in. (std) 0.0001 in. Limited only by mach capbl Limited only by mach capbl None Full Differential synchro
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Motors, hyd drives, cl servo Limited only by drive capacity 1 to 5 1000 in. 2000 ipm Varies with drive, speed	Motors, hyd drives, cl servo Limited by drive capacity 1 to 5 1000 in. 2000 ipm Varies with drive, speed	DC motor, hyd drives Not limited by control 5 is practical max Not limited by control Any reasonable machine speed Function of feed speed only	DC motors, hyd drives Not limited by control 5 is practical max Not limited by control Any reasonable machine speed Function of feed speed only
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Machine tool builder requirement Yes Input data, tool no., op no. ———	Machine tool builder requirement Yes Input, acti posit, tool no. ———	Eight auxiliary function relays operate from tape sig Yes None External interpolation	Machine requirement Yes Input, acti pos, tool & op no. Linear, circular, internal
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Elec tube Modular construction Tape parity check Yes, by General Electric 90 offices nationally Prog, operate, maintenance ———	Transistor Modular construction See addl information Yes, by General Electric 90 offices nationally Prog, operate, maintenance ———	Electron tube Modular construction None Yes, by General Electric 90 offices nationally Program, data prep, maint ———	Transistor Modular construction Test tapes check logic circuit Yes, by General Electric 90 offices nationally Prog, data prep, maint ———
Most suitable applications **Additional information**	Drilling, punching, boring, and milling machines	Drilling, boring, punching, milling, turning—shaft work Trouble shooting done with test tapes, which check all digital circuitry in control and isolate trouble should it occur. Average operator can easily perform maintenance with this procedure. Visual display of operation number is also standard	Large profile and skin mills, small vert profilers, boring mills, precision millers Control input is completely interpolated data consisting of phase analog signals. The information on magnetic tape is not coded in the usual sense of the word	Engine, turret lathes; mills, profilers, grinders—any continuous path application

Company name **Address** **Tradename or model number**	Giddings & Lewis MT Co 142 Doty St Fond du Lac Numeripoint for positioning	Giddings & Lewis MT Co 142 Doty St Fond du Lac, Wis Numeripoint (for verticals)	Giddings & Lewis MT Co 142 Doty St Fond du Lac, Wis Numeripoint (for horizontals)	Gisholt Machine Co 1245 E Washington Ave Madison 10, Wis Factrol
Control function **Control type** **Number of controlled axes**	Positioning Analog, absol, closed loop 2, simultaneously	Positioning Analog, absol, open loop 4, 2 simultaneously	Sequencing and positioning Digital, absol, closed loop 2 to 4, any 2 simultaneously	Contouring Analog, absol, closed loop 4, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dial ——— Tab sequential Leadscrew, transducer	EIA std tape No Manual Tab sequential Leadscrew & resolver	EIA std tape Yes, dial Manual or computer assist Tab sequential Inductosyn	2½-in. magnetic tape Yes, pushbuttons Analog computer Phase analog Transducer
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.001 in. ±0.001 in. ±0.0005 in. None Full range Single switch	0.001 in. ±0.001 in. ±0.001 in. ±0.0005 in. None Full range Manual	0.0001 in. ±0.0001 in. ±0.0002 in./ft. ±0.0002 in. 0.001 in./10 ft Zero offset offered ———	0.001 in. ——— ——— ——— ——— ±.050" long, .025" cross Phase
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	AC motor and servomotor 1/3 hp 2 58 in. 360 ipm .15 min average	Clutch-type Depends on feedbox capacity 4 axes & table speed 50 in. (1 step), 100 in. (2) ½ ipm for last 0.050 in. 10 sec (for precision)	Clutch or servomotor No limit 1 or 2 500 in. 120 ipm 12 sec	Cylinders 25 hp 4 38⅜ in. 175 to 180 ipm (2 drives) 7 to 8 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Coolant, seq no., tool change light No Input data, tool number Linear	Threading, taper turning, coolant, no dwell, prec posit No (just VTL turrets) Actual position Linear	Speed & feed control, spindle cycling, coolant control No Input data, tool number ———	Coolant, spindle speed & override, cycles, indexes, etc No Input, acti posit, tool no. External function of computer
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	——— Modular construction Sequential format Yes, by G&L Fond du Lac Prog, operation, maint ———	Elec tube, relay logic Individual panel construction Parity check, head overshoot Yes, by G&L Fond du Lac Prog, operation, maint $32,000	Electron tube Designed for simplified maint All phases Yes, by G&L Fond du Lac Prog, operation, maint $40,000	Transistor Modular construction ——— Yes, by Gisholt Madison All phases ———
Most suitable applications **Additional information**	Table or machine with long travels for work with widely spaced holes; tube sheets Control is one of Numeripoint family with many identical sections. Impulses from switching logic section regulate (on each axis) a constant speed AC rapid traverse motor & DC servomotor which gradually decreases approach speed	Parts with many machined surfaces requiring small movements, or internal work Trim potentiometers for tool wear or deflection	Designed for optimum results with G&L horizontal boring mills Display panel mounted in a waist-high trunnion on platforms of larger machines, floor pedestal for smaller ones. Optional equipment includes tape-actuated spindle cycling for floor-types, saddle depth cycling for table-type	Experimental system. If turret or tool post are not locked in position these units will not feed. Feedback on spindle speed, tool post, and turret index

N/C Selector Guide—Systems

Company name Address Tradename or model number	Hillyer Corp 244 Sheffield St Mountainside, NJ Hillyer	Indus Sys Div, Hughes Aircraft PO Box 90904 Airport Station Los Angeles 45, Calif NC-200	Indus Sys Div, Hughes Aircraft PO Box 90904 Airport Station Los Angeles 45, Calif MT-3	Lear, Inc, E-M Div 110 Ionia Ave Grand Rapids, Mich Command Control
Control function	Positioning	Sequencing and positioning	Sequencing and positioning	———
Control type	Digital, closed loop	Digital, increm, closed loop	Digital, increm, closed loop	Incremental, closed loop
Number of controlled axes	2, simultaneously	3, 2 simultaneously	5, 3 simultaneously	2 and 3, simultaneously
Input media	EIA std tape	EIA std tape	EIA std tape	Teletype tape
Manual input possible?	Yes, dial	Yes, dials	Yes, pushbutton	Yes, pushbutton
Programming method	Manual	Manual	Manual	Manual
Information coding method	Tab sequential	BCD, modified fixed seq	BCD, modified fixed seq	Teletype code and punch
Basic measuring system	Leadscrew	Leadscrew, transd, linear scale	Leadscrew, transducer	Leadscrew, commutator
Smallest input increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal system resolution	±0.001 in.	0.001 in.	±0.001 in.	±0.010 in.
Recommended accuracy range	±0.001 in.	±0.0005 in.	±0.001 in./ft.	±0.001 in.
Repeatability	±0.0005 in.	±0.0002 in.	±0.0003 in.	±0.001 in.
Maximum cumulative error	0.001 in.	None	None	0.001 in.
Zero offset range	———	Full range	Full range	12 x 12 in.
Zero shifting method	Declutch digtizer, man reset	Incremental logic	Incremental logic	On tape
Types of drives controllable	All types (electric)	DC motor & hyd cyl	Spind, elec; axis, hyd	———
Maximum drive power	1 hp	½ hp	Spind, 10 hp; axis, 5 hp	———
Number of drives controlled	1 per motion, 4 max	3	3 spindles, 5 axes	32
Longest practical motion	60 in.	48 in.	24 in.	12 x 12 (no design limit)
Maximum positioning feed rate	130 ipm (2 drives)	240 ipm	150 ipm (5 drives)	7.2 ipm
Time to move all axes 10 in.	5 sec	4 sec	4 sec	1.5 min
Standard auxiliary functions	Speeds, feeds, depth, coolant, mill, tap, peck drill	Mill, zero select, coolant, tool select, feed, speed	Head select, tool select, feed, coolant, rotate table	As required
Will it control tool changer?	Yes	Optional feature	Yes	If it can be switch controlled
Type of visual display	Input, acti posit, tool no.	Input data	Input data	———
Type of data interpolation	Linear	None	None	———
Basic circuit construction	All electric	Transistor	Elec tube (¼), transistor (¾)	All electric
Maintenance considerations	Modular construction	Modular construction	Modular construction	Modular construction
Self-checking capability	Fully interlocked & parity	Tape parity check	Parity check of input data	———
Maintenance service provided?	Yes, by Hillyer	Yes, by Hughes field service	Yes, by Hughes field service	Yes, by Lear
How many locations?	Mountainside	Nationwide	Nationwide	Chicago & Grand Rapids
Training offered?	All phases	All phases	All phases	Program, operation, maint
Average installed cost	$10,000 (2 axes), $16,000 (3)	$21,000	———	$6,000
Most suitable applications	Point to point positioning	Complete control of a turret drill press		For drilling machine aimed at small shapes, where spot facing is headache
Additional information			System designed for MT-3 manufacturing center	System, which is low-cost, does not require modification of machine tool, and can be set in operation with only short set-up time or teardown time, leaving machine for normal usage. Can normally be moved from one machine to another with only change of plug board

Company name Address Tradename or model number	Lear Inc 110 Ionia Ave Grand Rapids 2, Mich Command Control	Moog Servocontrols, Inc 44 Hamburg St East Aurora, NY Hydra-Point	Mullard Equipment Ltd Manor Royal, Crawley Sussex, England Autoplot Type L-288	National Automatic Tool Co National Road West Richmond, Ind Natcotrol L7-41
Control function	Sequence, position, contour	Sequencing and positioning	Positioning	Positioning
Control type	Digital, increm, closed loop	Absolute, closed loop	Incremental, open loop	Digital, absol, closed loop
Number of controlled axes	3, 2 simultaneously	2, simultaneously	Two, simultaneously	3 simultaneously
Input media	EIA std tape	EIA std tape	Decade switches	EIA, std tape
Manual input possible?	Yes, dial	Yes, dial	Yes, decade switches	Yes, dial & selector switches
Programming method	Manual	Manual	———	Manual
Information coding method	Straight binary	Fixed sequential	———	Word address
Basic measuring system	Leadscrew	———	Leadscrew	Leadscrew
Smallest input increment	0.001 in.	0.001 in.	0.001 in.	0.001 in.
Normal system resolution	±0.001 in.	±0.001 in.	±0.001 in.	±0.001 in.
Recommended accuracy range	±0.001 in.	±0.001 in.	±0.002 in.	±0.001 in.
Repeatability	±0.001 in.	±0.003 in.	±0.0005 in.	±0.0005 in.
Maximum cumulative error	0.0005 in.	None	0.002 in.	0.0015 in.
Zero offset range	0.100 in.	±0.020 in.	30 x 20 in.	100 in.
Zero shifting method	———	Manual knob	Moveable datum	Declutch feedback
Types of drives controllable	Motors & hyd cylinders	Hydraulic	———	Electro-hydraulic
Maximum drive power	3 hp	———	0.5 hp	Not limited by control
Number of drives controlled	2	———	Single motor	3
Longest practical motion	5 ft	30 in.	30 in.	100 in. (no limit with mod)
Maximum positioning feed rate	50 ipm	350 ipm (2 drives); 700 (1)	60 ipm	240, 34, 4, 1 ipm (4 stages)
Time to move all axes 10 in.	15 sec	———	10 sec (op dir); 20 sec (same)	5 sec (normal); 11 sec (accur).
Standard auxiliary functions	Up and down on Z axis, coolant on/off	Tool select, coolant, dwell, block no readout, milling	Drilling or center punching selection and operation	16 different auxiliaries available
Will it control tool changer?	Yes	Yes	No	Yes
Type of visual display	Tool number	Tool number	Input data, actual position	Input data
Type of data interpolation	Linear, internal	———	Linear	Linear
Basic circuit construction	Relay	Non electronic	Electron tube	Relay
Maintenance considerations	Designed for simplified maint	Modular construction	4 removable units	Modular construction
Self-checking capability	Incomplete command	Operation requires position	None	Parity check on tape input
Maintenance service provided?	Yes, by Lear field engineers	Yes, by Moog	Yes, by local agents	Yes, by Natco
How many locations?	Sales offices	Buffalo, NY; Paramus, NJ,LA	———	Richmond
Training offered?	Programming, operation	All phases	Training at Mullard works	All phases
Average installed cost	$5,500	Available from mach tool mfr	$7,000	$35,000
Most suitable applications	Complex sequencing control, table posit or rough path control of under one foot	Positioning, straight line milling control of drilling, tapping, boring machines	With press for making templets	System is designed for use with Natco machines
Additional information		A pneumatic-hydraulic tape control, which is entirely non-electronic		

Company name	Norden Div, United Aircraft	Norden Div, United Aircraft	Norden Div, United Aircraft	Pace Controls Corp
Address	3501 Harbor Blvd Costa Mesa, Calif	3501 Harbor Blvd Costa Mesa, Calif	3501 Harbor Blvd Costa Mesa, Calif	661 Highland Ave Needham Heights 94, Mass
Tradename or model number	Modumatic Series 100	Modumatic Series 400	Modumatic Series 600	Aero-Digitork X-Y Plotter
Control function	Position display	Positioning	Positioning	Path control system
Control type	Digital, absol, open loop	Analog, absol, closed loop	Digital, absol, closed loop	Digital, increm, open loop
Number of controlled axes	2 or 3, simultaneously	2, simultaneously	2 or 3, simultaneously	2, simultaneously
Input media	———	EIA std tape	EIA std tape	EIA std tape
Manual input possible?	———	Yes, dial switches	Yes, dial switches	Yes, keyboard, potentiometer
Programming method	———	Manual	Manual	Manual, computer
Information coding method	———	Word address	Word address	BCD with parity check
Basic measuring system	Rack	Leadscrew	Rack	Positive digital command
Smallest input increment	———	0.0001 or 0.001 in.	0.001 in.	0.001 in.
Normal system resolution	0.001 in.	0.001 in.	±0.001 in.	±0.001 in.
Recommended accuracy range	±½ LSD + .0005 in./32 in.	±½ least sq dist	±½ least sq dist	±0.0015 in.
Repeatability	1/10 the accuracy	1/10 the accuracy	1/10 the accuracy	±0.0001 in.
Maximum cumulative error	———	———	———	None
Zero offset range	———	Full	Full range	48 x 48 in.
Zero shifting method	———	———	———	Counter reset
Types of drives controllable	———	All	All electric & hydraulic	Rack and pinion
Maximum drive power	———	———	No limitation	———
Number of drives controlled	———	As required	As required	Two
Longest practical motion	Unlimited	No limit	40 ft max to date	48 in.
Maximum positioning feed rate	———	400 ipm	200 ipm	240 ipm
Time to move all axes 10 in.	———	Depends on machine	Dependent on machine	3 sec
Standard auxiliary functions	———	One 1-of-10, five 1-of-2	One 1-of-10, five 1-of-2	Pen up, down; print head; scribe
Will it control tool changer?	———	Yes	Yes	———
Type of visual display	Actual position	Input data, tool number	Actual position, tool number	Input data, actual position
Type of data interpolation	———	———	———	Linear
Basic circuit construction	Transistor & relay	Transistor & relay	Transistor & relay	Transistor
Maintenance considerations	Modular construction	Modular construction	Modular construction	Modular construction
Self-checking capability	Visual	———	———	Parity check
Maintenance service provided?	Yes, by Norden	Yes, by Norden	Yes, by Norden	Yes, by Aero Service Corp
How many locations?	Nationwide	Nationwide	Nationwide	Philadelphia
Training offered?	Operation & maintenance	All phases	All phases	All phases
Average installed cost	$10,000 to $15,000	$15,000	$25,000	$40,000 with table
Most suitable applications	Large production machines, horizontal boring machines, etc	Drilling machines	Large machines, as horizontal boring machines, planer type boring machines, etc	
Additional information	Expandable to full tape and widely used in production shops		System features absolute digital positioning with display of position.	System is basically a path control system which, with appropriate auxiliary functions and Digitork motor drive, may control any machine tool motion in two axes

Company name	Pace Control Corp	Pace Controls Corp	Pratt & Whitney Co, Inc	Reliance Electric & Engrg Co
Address	661 Highland Ave Needham Heights 94, Mass	661 Highland Ave Needham Heights 94, Mass	Charter Oak Blvd West Hartford, Conn	24701 Euclid Ave Cleveland 17, Ohio
Tradename or model number	Digitork	Digitork	P&W Electrolimit Numeric	Programmed Numerical Cntl
Control function	———	———	Sequencing, positioning	Sequence, position
Control type	Digital, absol, open loop	Digital, absol, open loop	Digital, absol, closed loop	Analog, absol, closed loop
Number of controlled axes	2, simultaneously	2, simultaneously	2 to 5, simultaneously	One to three, simultaneously
Input media	EIA std tape	EIA std tape	EIA std tape	EIA std tape
Manual input possible?	Yes, 5 dials per axis	Yes, handwheel, pushbutton	Yes, telephone dial	Yes, dial
Programming method	———	———	Manual	Manual
Information coding method	BCD with parity check	BCD with parity check	Tab and fixed sequential	BCD, tab sequential
Basic measuring system	Positive digital command	Positive digital command	Electrolimit measuring bar	Leadscrew (inductosyn opt)
Smallest input increment	0.001 in.	0.0001 in.	0.0001 in.	0.001" std, 0.0001" avail
Normal system resolution	±0.001 in.	±0.0001 in.	±0.0001 in.	0.000,01 in.
Recommended accuracy range	±0.0001 in.	±0.000,01 in.	±0.0001 in.	Depends on machine
Repeatability	±0.0001 in.	±0.000,001 in.	±0.000,050 in.	±0.0001 in. (elec)
Maximum cumulative error	None	None	———	None
Zero offset range	20 x 20 in.	14 x 60 in.	Full range	Full (avail, not std)
Zero shifting method	Counter reset	Counter reset	Knob adjust	Analog
Types of drives controllable	Leadscrew	Leadscrews	Electric motor	DC servo, AC motor, hyd servo
Maximum drive power	———	¾ hp	2 hp	No practical limit
Number of drives controlled	2	2	2 to 5	Same as no. of axes
Longest practical motion	30 in.	10 ft	60 in.	1000 in.
Maximum positioning feed rate	240 ipm	7 ipm	150 ipm	200 ipm
Time to move all axes 10 in.	3 sec	1.2 min	20 sec, approx	Depends on machine
Standard auxiliary functions	Tool indication	Workpiece load, true wheel	Any desired	±0.040 zero offset, backlash takeup, 2 on/off functions
Will it control tool changer?	Yes	Yes	Yes	Yes
Type of visual display	Tool number	None	Input data, tool number	Input, tool no. (if wanted)
Type of data interpolation	Linear	Linear	———	———
Basic circuit construction	Transistor	Transistor	Electron tube	Transistor
Maintenance considerations	Modular construction	Modular construction	Designed for simplified maint	Modular construction
Self-checking capability	Parity check	Parity check	Check circuit	Parity check
Maintenance service provided?	Yes, by Raytheon Co	Yes, by Raytheon Co	Yes, by P&W	Yes, Reliance
How many locations?	Burlington, Mass	Burlington, Mass	At customer's plant	All major cities
Training offered?	All phases	All phases	All phases	All phases
Average installed cost	$11,500	$13,500	$23,000	$9,500 to $21,000 (OEM)
Most suitable applications	Two axis positioning control for drilling, grinding, milling and lathe work; indexing	Any application where high accuracy is desired	Jig borers and inspection machines	Drills, compound tables, boring mills, jig borers, rotary punch presses, mills, lathes
Additional information	Operates on strictly digital basis, with positive command information, thus eliminating need for feedback. Because of simplicity, cost can be less than other equipment with same results. Increment of input can be any finite number, but speed drops with smaller inputs	Although this is 2-axis system, number of axes can be increased and other auxiliaries added. It can also be made to control paths at increased cost. Higher orders of increment motion and accuracy can be obtained, at a reduced rate of travel	Control converts digital data to analog	Standard system has tape, dial, or manual operation modes. Position feedback is by 3-speed resolver package attached to leadscrew. Fine resolver can be replaced by linear Inductosyn scales and sliders. Servo positioning drives available

Company name **Address** **Tradename or model number**	Rheem Electronics Div 5200 W 104th St Los Angeles 45, Calif M23, M33, M44, M54	Specialties, Inc Skunks Misery Road Syosset, NY Specialmatic	Sperry Gyroscope Co of Can. PO Box 710 Montreal, Quebec, Canada Std Positioning Control	Sperry Gyroscope Co of Can. PO Box 710 Montreal, Quebec, Canada Jig borer control
Control function **Control type** **Number of controlled axes**	Positioning Digital, increm, closed loop 2, 3, 4, or 5; simultaneously	Sequencing, positioning Anal, dig, incr, closed loop 3 to 4, simultaneously	Positioning Anal & dig, absol, cl loop 2 or 3, simultaneously	Positioning Analog, digital, closed loop 2 or 3, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dial Flexowrtr or tape prep unit Tab sequential Transducer	Key reader & dial positioning Yes, dials plus override Manual (computer built-in) Decimal, dial readout Transducer	EIA std tape Yes, rotary switches Manual Fixed seq (bin/dec) Transducer	EIA std tape Yes, rotary switches Manual Fixed seq (bin/dec) Leadscrew
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.001 or 0.0001 in. ±0.0002 to 0.0005 in. ±0.0002 in. None Full range Inherent	0.000,01 in. approx Infinite ±0.001 in. ±0.000,05 in. None Full range Dial for each end point	0.0001 in. ±0.0001 in. ±0.0005 in. ±0.0001 in. 0.0005 in. 0.010 in. (std) or others Electro-mech	0.000,01 in. ±0.000,001 in. ±0.000,08 in. ±0.000,05 in. 0.000,08 in. ——— ———
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Hyd, DC motor Unlimited No limit No limit 180 ipm, others 3½ sec	Hyd cyl, var speed motor As required As required 120 in. 400 to 600 ipm 2 sec	Hyd cyl, motors; elec motors Unlimited Unlimited Unlimited 1000 ipm 0.01 min	Hyd, electric motors Unlimited ——— Not limited by control 40 ipm 15 sec
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Coolant, Z mode, airblast, feed & speed, mill func Yes Input data, tool number ———	Stock feed, spindle speed (24), coolant, collet close Yes Input, actl posit, tool no. Linear	Tool change, head advence, turret select, feeds, speeds Yes Input data, tool number ———	Tool change, head advance, speed select Yes Input data, tool number ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Elec tube, transistor Modular construction Lights in modules, relay sec Yes, by Rheem Los Angeles All phases ———	Transistor Modular construction Interlocking failsafe posit Yes, by Specialties Inc Syosset, NY Prog, operation, maint $25,000	Electron tube Modular construction System self-analysis (opt) Yes, by Sperry Coast-to-coast offices All phases $12,500	Electron tube Modular construction System self-analysis (opt) Yes, by Sperry Coast-to-coast offices Prog, data prep, maint ———
Most suitable applications **Additional information**	Any discrete positioning, as drilling, boring, routing, and spot welding Positioning speeds depend on drive used; those given are for Burg 25AHT. System can control any type drive, has unlimited range, and almost unlimited auxiliary funcs including programmed feed rates in any axis, programmed spindle speeds	Multi-slide turret lathes, lathes, layout drill press, borers, mills, grinders Uses no tape, cams, or other pre-programming. Stainless keys, imprinted with function, inserted in photoelectricaly read drum, establish opn sequence. Setup man can determine several motions directly; end points determined by dials; tool wear adjustments possible during cut	Posit tables, turret drills, Long drills, and punch presses Service contract available	Ideally suited to precision jig borers where speed and accuracy are both essential Service contract available
Company name **Address** **Tradename or model number**	Sperry Gyroscope Co of Can. PO Box 710 Montreal, Quebec, Canada Control for SIP 3K CN	Square D Co 4041 N Richards St Milwaukee 12, Wis Rapac Class 8860, Type L	Square D Co 4041 N Richards St Milwaukee 12, Wis Rapac Class 8860, Type D	Thompson Ramo Wooldridge 455 Sheridan Ave Michigan City, Ind TRW-2000 Posit Control
Control function **Control type** **Number of controlled axes**	Positioning Absolute, closed loop 2, simultaneously	Sequencing, positioning Digital, absol, closed loop 3, 2 or 3 simultaneously	Sequencing and positioning Digital, increm, closed loop 6, simultaneously	Positioning Digital, closed loop 2 to 5, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dial & mechanical Manual Straight binary Leadscrew	EIA std tape Yes, switches, keyboards Manual Tab seq, fixed seq, let addr Transducer	EIA std tape Yes, switch, keyboard Manual Tab seq, fixed seq, let addr Leadscrew or rack	EIA std tape Yes, dial Manual, computer Word address Transducer
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.0001 in. ±0.000,01 in. ±0.000,075 in. ±0.000,06 in. 0.0001 in. Total range Mechanical	0.001 in. ±0.001 in. ±0.001 in. ±0.0005 in. None ±0.050" (std) or longer Dial	0.0001 in. ±0.001 in. ±0.0005 in. ±0.0005 in. None Floating zero ———	0.0001 in. ±0.0005 in. ——— ——— ——— Full range ———
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Hydraulic motors 0.5 hp 2 18 in. 40 ipm 25 sec	Electronic, AC motor, hyd Depends on application One per axis 100 in. 2400 ipm (less, higher acc) 3 to 5 sec	Electronic, hyd servo valve Depends on application One per axis Unlimited 400 ipm 3 to 5 sec.	Elec or hydraulic ——— Up to 5 ——— 500 ipm ———
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	——— No Input data, tool number ———	Spindle & feed speed select, tool select, coolant on/off Yes Final position, tool number ———	Spindle & feed select, tool select, coolant, etc Yes Input, actl posit, tool no. ———	——— Yes Actual position (available) ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Elec tube, transistor Modular construction ——— Yes, by Sperry Coast-to-coast offices Maintenance $28,000	Transistor Modular construction Parity, not at location Yes, by Square D Milwaukee and field offices All phases $11,000 (2 axes)	Transistor Modular construction Parity, incorrect codes Yes, by Square D Milwaukee & field offices All phases $9,000 (2 axes)	Transistor Modular construction ——— Yes, by TRW Michigan City All phases ———
Most suitable applications **Additional information**	 If table or head is not in position, operator gets no green light	Drilling, boring, st-cut milling, grinding, turning, spot welding, punching, others Transducer is non-wearing, non-cyclic, linear device. Accuracy not dependent on gearing, leadscrews, racks. Installation is simple, transducer is mounted as single unit. Rapid positioning is possible since it is not necessary to switch transducers when nearing position	Drilling, milling, boring, turning, grinding, spot welding, gaging, others	

Company name **Address** **Tradename or model number**	Thompson Ramo Wooldridge 455 Sheridan Ave Michigan City, Ind TRW-3000 Contouring Control	True-Trace Corp 9830 E Rush St El Monte, Calif True-Merical	Ultra-Sonic Precision Co, Inc 236 Fourth Ave Mount Vernon, NY Position Master	Wang Laboratories, Inc 12 Huron Drive Natick, Mass No. TRA-9W
Control function **Control type** **Number of controlled axes**	Contouring Digital, increm, closed loop 2 to 5, simultaneously	Contouring Incr, mech closed loop 2 or 3, simultaneously	Positioning Digital, open loop 2, simultaneously	Sequencing, positioning Digital, absol, open loop One
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, selector switch Manual, computer Fixed sequential Leadscrew, resolver	35-mm magnetic tape Yes, dial Computer ——— Leadscrew	EIA std tape Yes, dial Manual Straight binary Leadscrew, transducer	EIA std tape Yes, switches, pushbuttons Manual Binary coded decimal Transducer
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.0001 in. ±0.0002 in. ——— ——— ——— Full range Manual resolver	Function of max feed rate ±0.0005 in. ±0.0015 in. ±0.0002 in. 0.005 in. Length of slide Elec, hyd clutch	0.001 in. ±0.001 in. ±0.001 in. ±0.001 in. ±0.001 in. 11 x 18 in. Pushbutton	0.1 in. 0.1 in. ——— ——— ——— Not offered ———
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	Hydraulic 7.5 hp Up to 5 ——— 200 ipm 3 sec	Hyd cyl, motor; leadscrew Unlimited Unlimited 10-ft cyl (fl mot, longer) 200 ipm Function of feed rates	Leadscrew tables 1/6 hp 2 36" table, 18" movement 60 ipm 11 sec	——— ——— ——— 13 in. 20 ft/min ———
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Coolant, spindle on/off, scriber turret Yes Input data, tool number Linear, internal	Spindle, coolant, r/l-hand, rapid trav, pressure lube ——— Actual position Internal	Electrical tie-in for optional auxiliary functions No Input, acti posit, tool no. Linear	Feeds, speeds, stroke lengths, automatic functions No ——— ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Transistor Modular construction Tape error, servo error Yes, by TRW Michigan City All phases ———	Transistor Modular construction Auto shutdown features Yes, by True-Trace El Monte All phases $20,000 to $50,000	Transistor Modular construction Return to mech zero Yes, by Ultra-Sonic Precision Mt Vernon, NY 2-day course at plant $13,650	Telephone-type relays Designed for simplified maint ——— ——— ——— All phases $6,200 (2AB), $5,400
Most suitable applications	Surface grinders, lathes, mills, rail mills, drafting machines	Milling machines up to 10 ft travel	Short runs requiring layout of holes to be machined and straight-line end milling	Installed on Warner and Swasey single spindle automatics
Additional information	Specialized tape readers with servo spoolers and auto tape rewind available, also internal feedrate override, command multiplier	System is relatively low in cost, especially trouble-free. It is readily applicable to new machines, or as retrofit. 3-axis post-processor exists		Single switch on operator's control panel permits operation in either tape controlled automatic or std electro-mech operation. This allows continuous production with or without prepared tapes

Company name **Address** **Tradename or model number**	Wang Laboratories, Inc 12 Huron Drive Natick, Mass Weditrol	The Warner & Swasey Co 32-16 Downing St Flushing 54, NY Tele- & Pilot-Probomat	The Warner & Swasey Co 5701 Carnegie Ave Cleveland 3, Ohio SCA-25	Westinghouse Electric Corp 4454 Genessee St Cheektowaga, NY Prodac
Control function **Control type** **Number of controlled axes**	Sequencing, positioning Digital, absol, closed loop 2, simultaneously	Positioning Analog, digital, open loop 2 to 5, simultaneously	Sequence, position, contour Digital, increm, closed loop 4 (2 per turret), simul	Sequencing, positioning Digital, absol. closed loop 1 to 5, simultaneously
Input media **Manual input possible?** **Programming method** **Information coding method** **Basic measuring system**	EIA std tape Yes, dials Manual BCD and binary combination Leadscrew	EIA std tape Yes, dial Manual, computer if required Binary coded decimal Leadscrew, rack, pegbar	EIA std tape Yes, pushbuttons, switches Manual, computer Straight binary Leadscrew	Modified EIA std tape Yes, dial Manual or computer Word address Transducer
Smallest input increment **Normal system resolution** **Recommended accuracy range** **Repeatability** **Maximum cumulative error** **Zero offset range** **Zero shifting method**	0.001 in. ±0.000,25 in. ——— ±0.000,25 in. None Infinite Disengage encoder (toggle)	System resolution 3-4-5 decimal ±0.0005, 0.0001, 0.000,01" Same as operating accuracy None Infinite Electrical and/or mechanical	0.0005 in. ±0.0005 in. ±0.0005 in. ±0.0005 in. ——— Not offered ———	Determined by machine ±0.0005 in. ±0.0005 in. ±0.0005 in. None Full range Pushbutton
Types of drives controllable **Maximum drive power** **Number of drives controlled** **Longest practical motion** **Maximum positioning feed rate** **Time to move all axes 10 in.**	DC motor 1 hp One 75 in. 150 ipm 12 sec or less	AC, DC, Hydraulic No limit No limit 1000 in. 1000, 100, 100 ipm 3 to 4 sec (20 x 30" table)	Electric servo motor 1 hp 4 51 ipr 0.031 in. 6.6 (cross) 3.3 sec (trans)	All common types No limit 5 No limit Depends on accuracy, drive Depends on accuracy
Standard auxiliary functions **Will it control tool changer?** **Type of visual display** **Type of data interpolation**	Table clamp, tool select, quill up or down, coolant Yes Input data Linear	Any number, depends on requirement of machine tool Yes Input data, tool number Linear	Coolant, turret index No Input data Linear, internal	All EIA auxiliaries Yes Input, acti posit, tool no. ———
Basic circuit construction **Maintenance considerations** **Self-checking capability** **Maintenance service provided?** **How many locations?** **Training offered?** **Average installed cost**	Relay Modular construction Relay comparison unit Yes, by Wang Natick, Mass Program, data prep, oper $12,950	Elec tube, relay Modular construction Parity check, posit monitor Yes, by Warner & Swasey New York City All phases $18,000 to $37,000	Electron tube Modular construction ——— ——— ——— All phases ———	Transistor Modular construction None Yes, by Westinghouse All major cities All phases $7500 per axis
Most suitable applications	Vertical mills and turret drills, position, straight-line mill	Retrofit kits for DeVlieg jig-mils, rotary tables, horiz boring mills, others	Specifically designed and built for the SCA-25 machine	General two and three axis positioning, turret punch, jig borer, etc
Additional information				System is flexible enough that there are no established limits for accuracy, speed, auxiliary functions. Within mechanical limits of machine, almost any accuracy is attainable with proper speed adjustments to suit

Job analysis for numerical control

CHARACTERISTIC—REQUIREMENT	VALUE
SKILL	
Accuracy	
Dimensional tolerances	
Surface finish	
Permissible runout	
Maximum cumulative error	
Repeatability	
Accuracy of duplicated dimensions	
Dexterity	
Complexity of part shape	
Arrangement of holes	
Relationship of part surfaces	
Versatility	
Variety of different parts	
Wide range of requirements	
Several dimensioning systems	
Interpretation	
Complexity of data	
Volume of data	
Mirror-image requirement	
Auxiliary functions	
Variety of operations	
Need for operator instructions	
Production demand	
Coordination	
Number of degrees of motion	
Need for simultaneous functions	
Holding or clamping conditions	
Geometry of part	
Arithmetical ability	
Volume of data	
Accuracy of part	
Production demand	
Design sophistication	
EFFORT	
Horsepower	
Weight of part(s)	
Required metal-removal rate	
Material (machinability)	
Area covered	
Size of part	
Shape of part	
Pattern of operations	
Speed	
Production demand	
Material	
Optimum metal-removal rate	
Part complexity	
Finish requirements	
Job frequency	
Number of parts per order lot	
Frequency of job orders	
Production demand	
Data-input time	
Complexity of programming	
Production demand	
Degree of computation required	

CHARACTERISTIC—REQUIREMENT	VALUE
Data-access time	
Complexity of part shape	
Production demand	
Number of operations required	
Computation time	
Complexity of part geometry	
Number of non-linear functions	
Volume of data	
Dimensional tolerances	
Surface finish	
RESPONSIBILITY	
Equipment damage	
Value of machine controlled	
Cost of equipment downtime	
Effect of production delays	
Material	
Cost of unmachined part	
(or) Value of raw material	
Availability of material	
Piece	
Value added during N/C operation	
Effect of piece loss on assembly	
Cost of error to quality control	
Safety	
Size and power of equipment	
Maximum speeds and feeds	
Effect of failure on personnel	
Effect of failure on adjacent equipment	
Business prestige	
Effect of part loss on delivery	
Effect of error on new business	
Effect of inoperation on visitors	
Reflection of trouble on management	
JOB CONDITIONS	
Shop atmosphere	
Proximity to damaging fumes	
Excessive dampness or humidity	
Dust-laden air	
Shop temperature	
Sudden temperature changes	
Extremes of heat or cold	
Uneven temperature distribution	
Electric line transients	
Voltage fluctuations	
Shifts in frequency or phase	
Radio-frequency interference	
Maintenance capability	
Degree of equipment complexity	
Level of accuracy required	
Production demand	
Cost of downtime	
TOTAL VALUE:	

number of operations) developed for the 15 sample parts. These data were plotted and showed a virtually linear relationship.

For quick and dirty estimating, the number of operations required for any job can be picked off along the bottom of the graph, traced to the line and then traced to the pre-running and running costs.

Counting operations
Multi-operation machine
_____‡ Holes (Spot drill-all holes)
_____‡ Holes (Drill)
_____‡ Holes (Ream-Count 2 operations per hole)
_____‡ Holes (Counterbore)
_____‡ Holes (Countersink)
_____‡ Holes (Tap-Count 2 operations per hole)

Example: If 5 holes are to be drilled and reamed, total number of operations will be determined as follows:
5 operations—Spot
5 operations—Drill
10 operations—Ream
20 operations—Total

Milling Operations:
_____‡ Operations. Count one operation for each side of each figure milled. If tolerances are closer than ±0.010, allow two operations (rough and finish passes) for each side. When end milling, allow one operation for feed-in if mill enters on part and no entrance hole is drilled. When making cut-outs, allow adequate number of passes to remove all material.

Example: To mill a cutout ½ in. wide to ±0.010 tolerance with ¼-in. end-mill, full depth on first cut.
1 operation—Feed mill in
4 operations—Rough mill all 4 sides
4 operations—Finish mill all 4 sides
9 operations—Total
NOTE: Burring is normally done by the operator while the N/C machine is in operation.
Drilling operations:
_____‡ Holes (Spot drill—all holes)
_____‡ Holes (Drill)
_____‡ Holes

Example: If 20 holes are to be spotted and drilled, total number of operations will be determined as follows:
20 operations—Spot
20 operations—Drill
40 operations—Total
Conventional — Sensitive Drillpress milling machine, etc. Count operations as noted above for the multi-operation machine and turret drillpress, except count each milling operation as 5 operations.

Within the philosophy of numerical control, a wide range of equipment characteristics is available. Your needs may best be satisfied by a simple pushbutton sequencing device—or by a single-axis positioning system directed by dialed-in data.

On the other hand, you may want to produce giant forging dies. Now you must have a complex continuous-path machine with a sophisticated control system. If this machine is equipped with a "mirror-image" switch, you might save a lot of time and money. One thing is certain: your programming must be by computer. If you do not have one, and don't plan to get a computer, you must know where to get computer-programming service. It is available.

Far more likely, however, is the chance that you will want numerical-control equipment somewhere in between these two extremes. Do you want positioning, positioning-with-rate, or contouring? Can you do the job best with a combination of instrumentation and/or manual setup plus numerical sequencing? What will tape contribute?

Retrofit?

Is a standard N/C machine available to meet your need or must you have one designed and developed especially for your job requirements? Should you retrofit an existing conventional machine with N/C or acquire a machine designed for N/C? If you decide to retrofit, should you use a standard positioning-table package—or have a control system installed directly into the machine, as an integral part.

Incidentally, most people in N/C are dead set against this integral retrofitting of conventional machines. They say it just isn't practical; that the machine dynamics, the frequency response, isn't suited to the forces and speeds of automatic control. Other people say retrofit is practical if the conventional machine is suited to N/C.

Perhaps it would be fair to say here that it can be satisfactory, but retrofitting is seldom as big a bargain as it appears at first glance. The engineering, modification, and debugging time necessary to make a retrofit successful easily can run into a substantial cost. This bill may add up to very nearly the cost of a new N/C machine, built from the ground up to do its job. Yet the retrofit always remains less than the best.

How to decide what you need

To have a better idea of the combination of characteristics necessary to produce your product by N/C, prepare an analysis chart as shown on page 113. Using the characteristics described as a guide, add any other job requirement which you feel are pertinent to your product. The process analysis sheet will provide the details.

For each requirement set up a value within, for example, the range of zero to five, to indicate its importance. Give a "5" only to the most critical or serious demands. Use a "1" for characteristics that apply but are not essential to success. Use the numbers in between for degree of importance. "Dimensional tolerances" might be classified as a "5" for millionths and tenths of thousandths, a "4" for ± 0.001 in. or ± 0.002 in., a "3" for ± 0.005 in., a "2" for tolerances in hundredths of inches and a "1" for tenths of inches or fractional tolerances.

Measure relative importance

When all of these values are applied, total them. Now you have a picture showing where the emphasis should be in selecting equipment to best suit your manufacturing requirements. By taking sub-totals for individual characteristics and comparing them to the total, you can measure the relative importance of each characteristic. You can quickly check off each of your sample parts against these requirements to learn the range of capabilities necessary in the equipment. If one machine will not feasibly cover the range, which group of parts deserves your first attention?

Is a toolchanger practical? Look at the skill requirements. How many operations are required on typical pieces, how many tool changes? Can you get along without punched tape? How important is data-input time? What is operator error worth? What productivity do you need?

From this job analysis you also can decide how much programming will be necessary for the products you manufacture, and whether any staff additions are necessary. Data preparation and training requirements also can be determined.

With a clear picture of your requirements in both the parts and the N/C equipment, you are able to specify the most suitable equipment. You are able to sit down with builders and intelligently discuss your needs. You better understand what you are paying for, and can adjust your requirements to your budget.

Now you must justify your equipment investment in comparison with the other opportunities to invest the money profitably.

How to justify numerical control

Justify N/C? How do you justify a philosophy to a novitiate—in a dollar-and-cents world?

There are many occasions when we must realize that business, free enterprise, is a risk. We live in a profit and loss economy. Numerical control is new enough to require some speculation yet sufficiently proved to be considered a profitable growth investment. Equipment currently offered is not a gamble. The gamble is in our ability to select it soundly; then use it quickly, efficiently, and profitably.

Numerical control is not the answer to every production headache. It cannot always be justified over less expensive control methods. When the market demand warrants really large lot sizes, or production runs, automation or special equipment may be suitable.

Profit is made on frequency of inventory turnover. Manufacturing equipment should be designed, and selected, to produce its class of parts at the lowest overall manufacturing cost. (Stripping a standard machine-tool frequently converts it to a special tool; as such, its cost should be charged only against those parts which its limited capability permits it to produce economically.) The key is not how little you pay for a machine, but is how much it will do for you for its cost.

Rate your return

Cost is important. You can't invest money you haven't got—no matter how enticing an N/C justification may seem. Or you may have a limited budget and can purchase equipment only within its confines. Perhaps there are several places where the money can be put to work effectively. What should you do?

First, don't jump to conclusions. Always evaluate all of the seemingly important demands for the money. Rate them by the maximum return they offer. Invest in the most promising opportunities within your budget.

No matter what the opportunity is, if you cannot afford the capital required, and the investment seems worthwhile, consider borrowing or leasing. You pay "rent" for the money, and using it is no more disgraceful than using a rented building.

Before we discuss the approach to justification, perhaps it would be wise to look at some of the differences between N/C and conventional techniques. The wide range of capability offered within the N/C concept makes it imperative to understand these characteristics.

What is numerical control?

Numerical control is a fundamental philosophy of control. As a concept, it goes much deeper than the concept of automation, for example. For the first time in the history of making things, numerical control can *eliminate the human as a control element.* This characteristic is its most signicant contribution to improved control.

Man can interpret only one dimension, or value, at a time. He can coordinate no more than two dimensions simultaneously — and those crudely. Depending upon his skill, man interprets precise values with some degree of error. His "repeatability" is subject to his moods and physical well-being. He needs aids, such as jigs and fixtures, to remember multiple values and both his skill and his memory vary with fatigue.

Man is insecure in the knowledge that error brings censure. He is tortured by this ever-present danger, checking himself constantly to avoid it, yet is bored by drudgery.

We live in a world of science, a world in which mathematics plays a key role. Mathematics uses symbols, in the hands of scientists and engineers, to explain the interplay between the laws of nature, to envision new products out of this new knowledge, and to improve existing technology. However, these mental creations do us little good unless people skilled in manufacturing can convert the symbolism into physical form. Numerical control makes this conversion directly.

Because the concept of numerical control is basic, it has many degrees of application. Because this concept was essential to producing the complex mathematically defined shapes needed in modern aerospace vehicles, the US Air Force financed a major portion of its early development. N/C is not by any standards limited to this upper echelon of manufacturing requirements.

Even today, with the cost of continuous-path, or contouring, control being reduced, more than three-quarters of the systems being sold are for simple positioning, or point-to-point, operations. Numerical control's big advantage is that it is a basic measuring method.

Thus N/C virtually eliminates all the aids normally needed in conventional machining—such as jigs, fixtures, angle blocks, master plates, length bars, limit switches, and cams or templets. And N/C will repeat these instructions as often as desired within the allowable deviation.

Numerical control puts production control of the equipment directly into the hands of manufacturing management. Equipment under numerical control will operate at a constant level of production at whatever pace it is instructed to maintain. Optimum operating conditions are readily programmed.

Nevertheless, man as a control device, complete with computer and a set of manipulators, is highly flexible. One of his greatest talents is his ability to extend and amplify and refine the human limits of performance by developing tools. Numerical control is a tool just as fundamental as the concept of gearing or of electric motors. Numerical control extends skill as the other concepts amplify muscle.

Numbers are only symbols

Mathematics deals in symbols, an important set of which are numbers. As complicated as they may appear, numbers provide information symbols for only three functions—counting, measuring, and predicting. It is extremely important to remember that numbers are only symbols for values—they are not values in themselves—and that arabic numerals provide only one of many ways to symbolize these values.

Counting and measuring, in normal usage, are fairly simple functions. Predicting can be simple but it is more apt to be a fairly complicated function. Predicting may call for higher mathematics—and even for a computer.

For metalworking equipment, numerical control involves only the counting and measuring functions of numbers. Computers are not essential to most numerical-control applications. They are necessary only for advanced, complex programming or to speed tape preparation. Computers are tools of the advanced programmer.

"Numerical control" is exactly

Text continued on page 118

Where numerical control cuts costs

Compiled by Wiedemann Machine Company

Personnel

Numerical control offers several important manpower savings which are frequently by-passed. These are in addition to direct-labor savings.

AREA OF SAVING	Annual Savings or Per-Piece Savings
Operator confined to one machine	
Training for operators	
Training for other departments	
Supervision	
Labor-turnover problems	
TOTAL	

Design

Use of tape and tape control reduces or eliminates the need for detailed information to a shop. Dimensionless drawings, photographic templets, combined repeating patterns, automatic programmers, tape libraries, etc, reduce design and drafting time. Standardization of hole sizes simplifies design. Engineering changes and model changes may be recorded and quickly accomplished by changing a portion of the tape. Manufacturing restrictions are greatly reduced.

Engineering	
Drafting	
Engineering changes	
Model changes	
Standardization	
TOTAL	

Job preparation in shop

This item can best be described as the non-productive shop labor. The N/C machine eliminates all layout, minimizes set-up, eliminates all drawing interpretations and reinterpretations in the shop, and minimizes lead-time requirements.

*Set-up of tools	
*Set-up of work positioning	
*Layout of parts	
*Manufacture of templets	
Drawing interpretation	
Drawing reinterpretation	
TOTAL	

*May be repeated from direct savings—do not include twice

Annual Direct Savings

Cost of direct labor plus depreciation and maintenance used to change raw material into a completed part. (Effect of higher productivity.)

Present Method	
_____Machine operators @ $	
_____Set-up men	
_____Layout men	
_____Other manpower	
All machines used (depreciation & maintenance)	
Present (annual) direct cost	
Numerical Control (subtract from above)	
_____N/C operator @ $	
_____Tape maker	
(Depreciation & maintenance)	
(Annual) direct cost of N/C	
Net (annual) direct savings with N/C	
Plus: Additional savings first year (salvage value of present machines used)	
TOTAL	

Lead-time allowances

Lead-time allowances, which are greatly reduced by N/C, cause very costly traffic jams in almost every shop. The cost of tools or layout, or set-up, or any of the factors listed below, is often exceeded by the additional cost of delay before they are completed for use in production. Savings should show the estimated cost of delays in each area or how much it is worth to have each job move through the plant much faster.

Tool designing and tool making	
Templet designing	
Templet making	
Processing	
Detailed drawings	
Setups	
Layout	
Area-to-area handling	
Inspections	
Simple engineering changes	
TOTAL	

Tools

Tool costs (jigs, fixtures, etc)	
Tool inventory control & storage	
Toolholders	
Tool purchasing and records	
Tool damage and maintenance	
Perishable tools	
Multiple tool setups	
Tool design	
Skilled tool inspectors	
TOTAL	

Production control

With tape replacing or simplifying detailed process cards, and with the continuity of production rate, production control departments have considerably less to do in placing and scheduling work. The single method of producing most part shapes further simplifies this function. Time studies are positive. Preparation of detailed process cards is eliminated. Full machine-loading is simplified.

Machine loading	
Work scheduling	
Delivery dates	
Time study	
Varied methods	
Detailed process cards	
Adherence to specified method	
More accurate estimating	
Printing	
TOTAL	

Handling

This subject covers all phases of handling whether it be handling in and out of the same machine several times, handling a lot from machine to machine, handling part from operator to operator, handling lots from area to area, etc.

Lots area to area	
Lots machine to machine	
Parts several time at same machine	
Parts operator-to-operator	

Waiting for handling equipment _____
Unused time of handling equipment _____
Riggers, truck drivers, laborers, etc _____
TOTAL _____

Quality control

Tape control assures consistently accurate parts each time a lot is run. N/C tolerances are far closer than most fabricating requirements, and at less cost. Part inspection, once a tape is proved correct, is unnecessary. Single handling, single part positioning reduces chance of operator error and resulting inaccuracies. Overall accuracy and quality is much better than can possibly be produced by typical conventional methods.

High close-tolerance cost _____
Inconsistencies _____
Scrap costs _____
Cost of individual part & lot inspection _____
Delays _____
TOTAL _____

Floor space

Replacing several machines with one obviously saves floor space. Now consider all the other areas in which reduced requirements mean space saved.

Shop
- Machine area _____
- Layout area _____
- Templet making _____
- Templet storage _____
- Parts at machines _____
- Lots at machines _____
- Lots in storage areas _____
- Stock storage _____
- Tool storage _____

Drafting _____
Production Control _____
Inspection _____
Handling Aisles _____
TOTAL _____

Equipment advantages

Numerical control eliminates many diesets, multiple-tool setups, handling operations, storage areas, etc., resulting in equipment savings in many areas. Almost each time a substantial savings is realized in any area, it results in a savings in equipment used in that area. Sometimes elimination of certain items that are seldom used results in an extraordinary saving. Salvage value, or percent thereof plus depreciation, may be used for first year and depreciation for subsequent years. (This factor may be used by some in computing *Direct Savings*.)

Machinery
- Templet making _____
- Tool making _____
- Support equipment _____

Stand-by Equipment (Seldom used)
- Cost _____
- Floor space _____
- Maintenance _____
- Current _____

Handling Equipment _____

Storage Facilities for
- Tools, templets _____
- Work in process _____
- Stock _____
- Blueprints _____
- Layout equipment _____
- Inspection equipment _____

TOTAL _____

Production

Numerical control is three to five times, or more, faster than manually operated equipment of same capacity. It is many times faster than traditional short-run methods used by many fabricators and manufacturers. Work is completed in a single operation with one operator who may also run a second machine or perform other operations. Steady production rate eliminates most of the lost time normally written off as fatigue time, allowances, etc. Frequently several operations, even in high-production shops, are produced in the same handling. Machine utilization is high.

Restricted flexibility _____
Several machines required _____
Slow miscellaneous methods _____
Fatigue allowances _____
Several operators _____
Several handlings _____
Interrupted production _____
Costly engineering changes _____

Some of these savings may be included elsewhere. Combined they illustrate the cause of excessive shop costs.

TOTAL _____

Standardization

The survey usually made to adopt numerical control points up many spots where standardization can pay off:

Hole sizes _____
Part Design _____
Methods _____
Inventory _____
Reduced Setup _____
Simplifies changes in:
- Design _____
- Processing _____
- Production _____
- Inspection _____
- Training _____

TOTAL _____

Miscellaneous

Volume potential is invariably increased to permit expansion of business at reduced cost.

Hole centers may be infinitely close, without additional handlings or change in procedure.

Electrical current requirements are reduced.

Inventory

Reduced lead time and simplified methods permit producing parts from tape as they are required with savings at several points.

Reduced inventory _____
Reduced records _____
Reduced obsolescence _____
Reduced taxes _____

Also note "stock storage" under *Floor Space* and "tool inventory" under *Tools*.

TOTAL _____
GRAND TOTAL [ ]

Assembly

More accurate components reduce assembly time and permit assembly by less skilled men.

Fitting at assembly is reduced.

Simple positioning and assembly fixtures may be used even for small lots.

Assembly fixture may be made directly on the machine by N/C.

Sales

Even the sales force will feel the impact of numerical control:

Better quality
Shorter deliveries
Sell in low quantities at a profit
Meet customers' special requirements
Simplified elements make estimating and quoting fast and positive—more accurately and more economically.

HERE ARE THE FIVE MAJOR METHODS OF

	BASIC METHOD	OTHER NAMES OR VARIATIONS	FACTORS INFLUENCING: EARNINGS OR SAVINGS — OPERATING EXPENSE: ANNUAL OPERATING EXPENSE	OPERATING EXPENSE: DOLLARS ADJUSTED FOR TIME-SHAPE OF EXPENSE: e.g., low in early years, high in later	OPERATING RECEIPTS: ANNUAL OPERATING RECEIPTS	OPERATING RECEIPTS: DOLLARS ADJUSTED FOR TIME-SHAPE OF INCOME: e.g., high in early years, low in later	EQUIPMENT OR FACILITY LIFE: SERVICE LIFE OF PROPOSED FACILITY	SALVAGE VALUE OF PROPOSED FACILITY	SALVAGE VALUE OF OLD FACILITY	DEPRECIATION METHOD CHOSEN—Straight-line, sum-of-digits, or declining balance
. . . THESE TWO ARE ROUGH AND READY, OFTEN MISLEADING										
1	ACCOUNTING METHOD	Average Book, Return on Original Investment, Return on Average Investment, First Year's Profit	√		√		√	√	√	
2	PAYBACK METHOD	Pay-Out, Pay-Off, Cash Recovery Period	√		√				√	
. . . THESE THREE ARE COMPLEX, BUT SURER YARDSTICKS										
3	ANNUAL COST METHOD	Compound Interest Method	√		√		√	√	√	Annuity and Straight-Line
4	IMPROVED MAPI SYSTEM	MAPI Formula (Machinery and Allied Products Institute)	√	Choice of 3 Time-Shape Patterns	√	Choice of 3 Time-Shape Patterns	√	√	√	√
5	INVESTOR'S METHOD	Discounted Cash Flow, Interest Rate of Return, Profitability Index. Also Present Worth Method and Capitalized Annual Cost	√	√	√	√	√	√	When net investment is used	√

Five rating methods for equipment investment. Checkmark indicates that analysis method normally includes the factor checked. Factors can be different in variations on these methods. Jones & Lamson version of Improved MAPI includes inflation factor, if desired. *Chart courtesy Factory magazine and Lloyd G Smiley, professional engineer*

what the term implies: *Control by the numbers. Any control system can be said to provide numerical control if it can directly convert symbolic numerical values into physical values, such as quantities or dimensions.*

All other elements of the system, such as whether or not the numbers are put in from a punched tape, or whether the input is from a push-button or a dial, or whether or not the system includes feedback, are secondary functions. These are not essential to the basic concept.

A system does not have to have punched tape, punched cards, or magnetic tape to provide numerical control. These devices are simply memories, external information-storage media to feed data to the control. Whether or not you need them depends upon your particular application of N/C.

In evaluating control systems, it is extremely important to recognize the distinction between numerical control and other control forms. Not all pre-programmed equipment is numerically controlled. Record-playback or tape-templet systems, in which the inputs are physical values, are not numerical-control systems.

Similarly, machines which are pre-programmed by setting length measures or limit stops and then sequenced by, for instance, a ratchet and pawl, are not numerically controlled. However, machine tools are being used in which dimensions are put in as physical values, by mechanical means, and then the cycle of operations is sequenced by numerical control. Costs, capability, accuracy, productivity, flexibility, setup requirements—all are affected by these differences.

Which formula is sound?

Next to hunch, the "pay-out" or "pay-off" system of evaluating the profitability of a piece of proposed equipment is by far the most popular. It is one of two broad classes of evaluation system. The other one is "return on investment."

Pay-out works like this: A company plans to buy an N/C machine for an installed cost of $12,000. It will replace a machine that can be sold for $2000. Net cost equals $10,000. Before taxes, the company will save $5000 per year on the new machine. It will pay for itself, recover its cost, in two years. Or in four years after taxes.

CALCULATING RATE OF RETURN ON INVESTMENT

CALCULATIONS										
	INVESTMENT COST			COST OF MONEY					KEY ADVANTAGES	KEY DRAWBACKS
	INSTALLED COST	DOLLARS ADJUSTED TO TIME-SHAPE OF INVESTMENTS; i.e., when capital outlay takes place	EXPENSING (vs. capitalization) POLICY ON INVESTMENT	INTEREST RATE ON BORROWED CAPITAL	EXPECTED RATE OF RETURN ON EQUITY CAPITAL	INCOME TAX	PROPERTY TAX	PRICE INCREASES OR DECREASES (inflation or deflation)		
	√		√			√			Easy to calculate. Easy to compare with company accounting figures.	Provides bobtail analysis only. Reliable only when annual receipts are uniform and project lasts its useful life.
	√		√			√			Good first cast. Yields indication of risk. Quickly drops out projects with long payback period.	Not really a rate of return.
	√	√	√	√	√	√	√		Good for stable investments with uniform savings such as service equipment (boilers, etc.). Easy to understand; can be used for budgeting.	Poor for projects with fluctuations in annual costs. Has limitations in ranking unlike proposals.
	√		√	√ Fixed	√ Fixed	√	√		Good for cost reduction, modernization and replacement projects. Yields readily understandable rate-of-return figures. Computations simplified by charts.	Depends upon comparison with existing facility. Assumes experience will repeat itself.
	√	√	√	Not required	Not required	√	√		Evaluates expenses and incomes as they occur. Good for large, medium, and small projects. Good for ranking purposes.	Difficulty in forecasting future expenses and incomes. Terms and data inconsistent with common accounting practices.

Payout is a little like certain mutual investment funds. You don't get a dividend until you've written off the charges. By this method, the company's profit on the new machine is *zero* until the fifth year of ownership—through the most profitable years of the machine's service life.

If your aim is to recover your investment as quickly as possible, save your money by not buying the machine and you will be 100% successful—and out of the manufacturing business.

Most companies would like their equipment to show a profit on the capital investment from the first hour of operation. This profit, or at least profit potential, should continue to flow throughout the useful life of the equipment. Ultimate profitability, then, is the factor to measure and evaluate.

Normally, the recovery of a capital investment in two or three years is too demanding a replacement criterion. Your existing facilities must get extremely inefficient before the profit differential is sufficient to warrant the purchase of new conventional machines. (By comparison with N/C equipment, even the latest designs of conventional machines can seem extremely inefficient.) If a check of your shop shows that most of your facilities can be replaced by equipment that will "pay for itself" in one to three years, you are probably pouring profit down the drain. In this sense, pay-out can be helpful.

Return-on-investment is an evaluation method just the opposite of pay-out. It works like this: Analysis of a proposed machine, costing $12,000 shows that it will save your company about $4000 per year over the old equipment. Then you figure your

Checklist for a Good Formula

- It solves the right problem.
- Its assumptions are clear and specific.
- It projects future deterioration and obsolescence.
- It allows for differences in service values.
- It allows for Income Tax.
- It handles present and future salvage values.
- It accommodates future capital additions.
- It is adaptable to a wide range of projects.
- It provides a consistent ranking procedure.
- It is simple to understand and apply.
- It considers all related costs.
- It presents an answer in usable form.

depreciation allowance, deciding that the machine can be written off in 12 years. This rate averages out at $1000 per year.

Thus the saving per year is $4000 less $1000, or $3000 per year. Income tax cuts this saving by 50%, to $1500. Because the machine cost $12,000, $1500 offers a rate of 12½%. This formula sounds business-like, but what does it prove? Can you project, with any accuracy, many years in advance, the expenditures and receipts that will occur? What will money cost 10 years from now?

MAPI offers the most practical investment analysis. It aims to show how the business would profit with and without the project, and how much saving or operating advantage there would be in the next year with the investment. MAPI applies principally to depreciable assets for replacement, improvement, and expansion projects. In these areas it is more versatile than most methods. Variations on MAPI include the General Electric method, and the Jones & Lamson method, which takes inflation into account.

Department of Defense Form DD-1106, the official form required to justify installation of all Defense Department-owned manufacturing equipment, is widely used for numerical control. Based on the MAPI system, it is somewhat easier to use. Though not perfect, it satisfies the government. One rule: *Don't waste time providing much more justification than you need to assure authorization to invest!*

The improved MAPI system is easy to comprehend and apply. It's especially good in cost-reduction and modernization proposals. All compound-interest calculations, tax depreciation, earnings patterns, etc, have been simplified by charts and tables. Forecasting years ahead is simpler than in other return-on-investment formulas.

For consistency, the one-year test meets prevailing practice, existing methods, and management thinking. It's a reasonable projection. The system ties in with capital budgeting.

No perfect method

As a method for evaluating numerical-control equipment investment, the principle behind the MAPI system is sound. *The technique falls down, though, in that it doesn't spell out with sufficient clarity all of the operating advantages of N/C.* To use the MAPI system effectively, you must expand this projection pattern to encompass all of the values available with numerical control. You can do this job most simply by using the table on page 116 as a guide. Normally data collection for MAPI-system use is simple. Numerical control makes the task somewhat more complex.

Several factors must be considered. First, the first-year test may have to be modified to get past the learning curve that is inherent in complex, and especially prototype, equipment. On standard N/C machines this problem is less likely to occur. Second, the useful life of the control system may be different from that of the machine.

The latter worry generally is unnecessary. With normal preventive maintenance, the control system should keep pace with the machine throughout the useful life of the latter. And, because numerical-control equipment is both general purpose and extremely versatile, the market for second-hand machines should be good for many years to come.

How to finance acquisition

Having proved to yourself and your company that N/C will be profitable, how do you acquire it. If your budget, and your company's bank balance, is sufficient to meet your requirements, there is no serious problem. (Although even here you may wish to consider whether to deplete your cash.) But what do you do when the return is rosy and you don't have the money?

Modern management attitudes are that use, not ownership, is the key to profit. It is in your interest, and in the national interest, to put money profitably to work. Of course, you will want the cheapest money you can get. Generally, the degree of risk you represent to the lender sets the rate you pay for the money.

Banks, almost invariably, are the least expensive source of money. But banks generally are more interested in *short-term* loans than in long-term equipment loans. Typical financing includes: mortgages, term loans, short-term loans, chattel mortgages, conditional bill of sale, factoring, sale of stock, bonds, loans against inventory, loans against accounts receivable, and leasing. Banks can handle all of these, but are more concerned with mortgages and term loans.

Funds are available from banks, brokers, industrial finance houses, factors, private investors, loan agencies, government, and a few relatives. From the condition of your business and your credit you can best decide which funds and sources best suit your need—and which are available to you. The cost increases with the risk to the lender.

Also, before you commit too much of your ready cash, remember that *each new addition to your plant is likely to increase your operating expense needs.* Of course, *replacement* of obsolete equipment might reduce the operating expense.

Leasing numerical-control equipment is one answer to its high-cost, especially in view of the high return offered by N/C equipment. If you have ignored leasing as too costly, it might pay you to reconsider it for N/C. Leasing is the most expensive kind of borrowing (in a sense you borrow the equipment instead of the funds) but it also is the least risky.

Leasing accomplishes the same purpose as a time-payment plan at somewhat lower monthly cost. However, you never own the equipment. Also, renting may eliminate the red tape required by company purchasing procedures.

You may ask, "If I can get bank credit, why should I lease?" First of all, if you are working with a leasing organization you get 100% financing, because you can finance your complete requirement without leaving something like 20% of your money on deposit in the bank as a compensating balance. Furthermore bankers prefer short-term loans. Leasing can improve your cash-flow.

If you have a definite application for numerical control and can justify it by showing profitable utilization for two years ahead, acquire the equipment you need. Chances are good that any benefit shown by a careful analysis will prove even more profitable in practice. •

Reprints are available of this and all other AM/MM special reports.

Order from Reader Service Dept, American Machinist/ Metalworking Manufacturing, 330 W. 42nd St, New York 36, NY. Single copies of this report are 75¢, prices are reduced for quantities over 100. A list of current reprints including previous special reports on numerical control is available from Reader Service Dept.

MACHINE IT FOR LESS / CINCINNATI

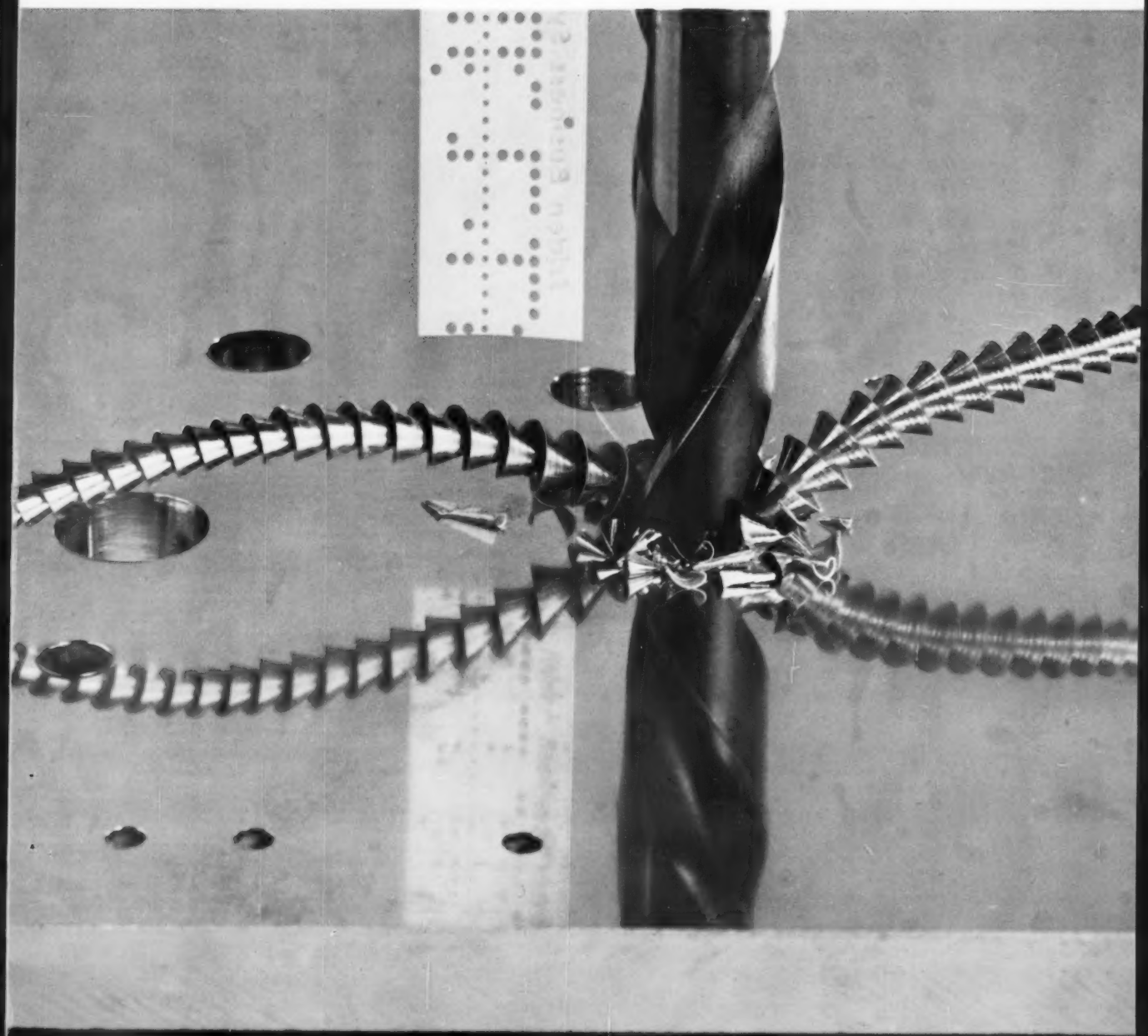
A 7-man shop drills holes like these with tape control

You don't have to be a giant to gain big savings through numerical control. A small, seven-man shop located on the eastern seaboard has demonstrated this fact over and over with a recently installed Cintimatic Drilling Machine.

Numerically controlled with tape programming, the new unit permits fast production while maintaining positioning accuracy with uniform tolerances. It eliminates need for costly drilling jigs and minimizes set up time. Moreover, ACRAMATIC control reliability permits use of Cintimatic Drilling Machines in any shop, even those which do not have a high level of electrical maintenance.

Cintimatic Drilling Machines, produced by Cincinnati Lathe and Tool Co., now put tape-controlled drilling within reach of every manufacturer. For complete details and specifications, turn the page.

CINCINNATI



CINTIMATIC 25-INCH DRILLING MACHINE:

*Base Price $14,500 complete, including controls**

The basic drilling unit is the head and upper frame of a standard Cincinnati sliding head drilling machine, powered by a 3-hp drive motor. Cincinnati INFISPEED variable speed drive is standard equipment. The unit is mounted on a rugged, fixed base with built-in leveling screws.

The large work table travels on ball bearings supported on hardened rod ways, rigidly supported along their entire length. Table motion is achieved by hydraulic cylinders. Position is determined by a feed back unit operating from a precision, backlash—eliminated rack and pinion.

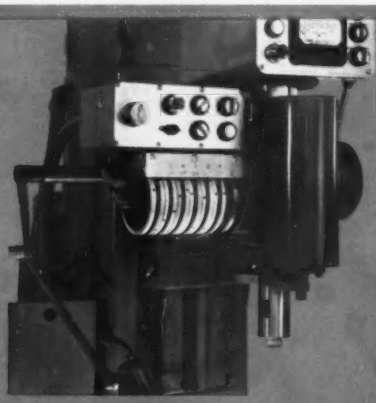
While the drilling unit and table are produced by Cincinnati Lathe and Tool Co., the ACRAMATIC Control Console is manufactured by The Cincinnati Milling Machine Co. Result: responsibility for satisfactory performance rests with one source—Cincinnati, second to none in machine tool engineering.

Call your Cincinnati Lathe and Tool distributor for complete information. Or write Cincinnati Lathe and Tool Co., subsidiary of The Cincinnati Milling Machine Co., Cincinnati 9, Ohio.

*Price subject to change without notice.

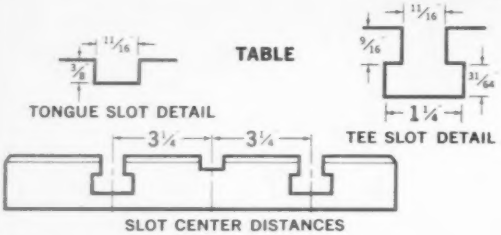
25-INCH CINTIMATIC DRILLING MACHINE

ACRAMATIC Control Console permits full tape control or manual operation of machine with ultimate in reliability.



The AUTO CYCLE adds an economic and high-production automatic spindle cycle for drilling and tapping to the standard power feed, a popular extra-cost option.

SPECIFICATIONS



Longitudinal travel	19.999 in.
Cross travel	9.999 in.
Working surface	26 in. x 12¾ in.
Tee slots	2
Tongue slots	2
Drive	Hydraulic cylinders
Positioning rate	120 in. per minute
Absolute positioning accuracy	±.002" in 12 in.
Repeatability	±.0005"

CONTROL

Type	Cincinnati ACRAMATIC
Electrical Supply	220/440 volts, 60 cycles, three phase
Tape	1-in., 8-track

25-INCH DRILL

Horsepower	3
Spindle	No. 4 Morse taper
Spindle speeds, back gear drive	60-1825 rpm
Rates, power feed	.002, .004, .007, .010, .015
Spindle travel	8¾ in.
Distance—spindle to table—min./max.	2¾/19½ in.
Distance—dovetail to spindle center	12⅞ in.
Vertical adjustment—sliding head	8 in.

STANDARD EQUIPMENT

Complete CINTIMATIC Drilling Machine includes motor, controls and INFISPEED drive; ACRAMATIC control console with electrical equipment, hydraulic power supply and tape reader; positioning table.

CINCINNATI

Barrel-Finishing Guide—I

By William P Nunn, field engineer, Minnesota Mining & Manufacturing Co, St Paul, Minn

New equipment, media and techniques make it possible to barrel finish parts that could not be considered a few years ago. Parts previously finished by rotation alone are now finished in shorter cycles and in larger loads by newly developed machines. Some of these operate on the vibrating-rotating principle or vibration alone. In certain cases, some of these installations have been automated.

Media development is likewise keeping pace with new finishing requirements. For example, ceramic-bonded aluminum oxide is lighter than fused aluminum-oxide chips, to reduce surface impingement and lodging problems. Preformed abrasives may increase cutting rates over 200%, as compared with random-shaped chips. Other new media will barrel finish chrome-plated zinc die castings to resemble a hand-buffed piece.

Performance in barrel finishing is not a happenstance. Carefu'ly planned and recorded test runs will set a pattern for barrel finishing. See rules for making a test run, and the equipment chart.

How to Test Run a Barrel-Finishing Job

1. Select the chip that will not lodge in any part opening, and that can be separated by screening. The chip should be either larger or smaller than the part, depending on the finish required: large for faster cut and coarser finish; small for slower cut and finer finish.

2. Load chips into cylinder to a 40 to 50% level.

3. Add enough work load (parts) to raise the total level to between 50 and 60% of the barrel's capacity.

4. Add abrasive or burnishing compound.

5. Put enough water into the load: a low level for maximum cutting—a high level for burnishing or cleaning.

6. A good trial run speed is 15 rpm in a barrel 30 in. in diameter. As the diameter of the barrel decreases, speeds may be increased.

7. Check the work after 10 turns, after 20 turns, then at 5- and 15-min. intervals. If no undesirable results appear after the 15-min. interval, continue the run with periodic inspection until the finish has been achieved.

If the operation has been a cutting or grinding run, and polish is required, a second stage follows:

8. Flush the barrel thoroughly with water, because traces of abrasive or dirt will retard polishing action. This is done through a screen door.

9. To polish, cover the load with water to 3 or 4 in. above the mass.

10. Add burnishing compound, preferably an all-purpose material for use on all metals.

11. Seal the barrel and run 45 to 60 min.

12. After attaining the desired finish, flush the barrel with clear water and empty the load into a screen coarse enough to allow chips to drop through, but fine enough to retain the parts.

The above procedure is normally used in conventional rotating barrels. In the vibrating-rotating barrel, chips and work load should reach a level of 75 to 80%. Rolling room is not needed as vibratory action replaces sliding action. Barrel speeds at 4 to 8 rpm give best results. Speeds above this point retard the vibratory effect. In tub-type machines, chip levels should be maintained at 80 to 90% capacity.

Equipment Chart for Barrel Finishing

Type of Parts	Conventional Rotating Barrels	Vibrating Rotating Barrels	Vibrating Tub Type Machines
Metal Stampings			
Media-to-parts ratio	2 to 1	1 to 1	1 to 1
Media level	55%	80%	80%
Media type	Natural stone Fused abrasives Ceramic shapes	Same	Same
Water—cut	½ gal./100 lb media	Same	Same
—polish	2 in. over mass	½ gal./100 lb media	¼ gal./100 lb media
Speed of rotation	18 to 20 rpm	6 rpm	
Frequency vibration		2700	2700
Amplitude		maximum	maximum
Machined Parts			
Media-to-parts ratio	4 to 1	3 to 1	3 to 1
Media level	60%	80%	80%
Media type	Fused abrasives Ceramic shapes	Same	Same
Water—cut	½ gal./100 lb media	Same	Same
—polish	2 in. over mass	½ gal./100 lb media	¼ gal./100 lb media
Speed of rotation	12 to 14 rpm	4 rpm	
Frequency vibration		2700	2700
Amplitude		medium	medium

250,000 full turns, more than a lifetime of service, and the amount of wear on ratchet drive lugs, or tangs, is practically unnoticeable. Corners remained sharp and clean and the surface unmarred.

What kind of steel does New Britain specify for these vital parts? What kind of steel offers this combination of high torque strength, high surface resistance to wear and Brinelling, plus uniform machinability? An alloy steel, of course . . . Aristoloy 4150 to be specific.

Write today for complete information about Aristoloy alloy steels in leaded and unleaded grades. Ask for Product and Facilities Catalog or call your nearest Copperweld representative.

Wear-Proof Tangs... Alloy Steel of course

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Barrel-Finishing Guide—II

Equipment Chart for Barrel Finishing *(Continued)*

Type of Parts	Conventional Rotating Barrels	Vibrating Rotating Barrels	Vibrating Tub Type Machines
Zinc Die Castings—Preplating finish			
Media-to-parts ratio	5 or 6 to 1	3 to 1	
Media level	65 to 70%	80%	
Media type	Resin-bonded shapes Natural stone	Same	
Water—cut	½ gal./100 lb media	Same	
—polish	1 gal./100 lb media	Same	
Speed of rotation	12 to 14 rpm	4 rpm	
Frequency vibration		2700	
Amplitude		minimum	
Removal flash and parting lines			
Media-to-parts ratio	3 to 1	2 to 1	2 to 1
Media level	50 to 55%	80%	80%
Media type	Natural stone Resin-bonded shapes	Same	Same
Water—cut	½ gal./100 lb media	Same	Same
—polish	2 in. over mass	½ gal./100 lb media	½ gal./100 lb media
Speed of rotation	16 to 18 rpm	4 to 6 rpm	
Frequency vibration		maximum	maximum
Amplitude		medium	medium
Hardware (wrenches, pliers, tools, etc.)			
Media-to-parts ratio	2 to 3 to 1	2 to 1	2 to 1
Media level	50%	80%	80%
Media type	Fused abrasives Ceramic shapes		Same
Water—cut	½ gal./100 lb media	Same	¼ gal./100 lb media
—polish	2 in. over mass	½ gal./100 lb media	½ gal./100 lb media
Speed of rotation	16 to 18 rpm	6 rpm	
Frequency vibration		2700	2700
Amplitude		maximum	maximum
Sand Castings (up to ¼ lb each)			
Media-to-parts ratio	3 to 1		2 to 1
Media level	50%	2 to 1	80%
Media type	Fused abrasives Ceramic shapes	80% Same	Same
Water—cut	½ gal./100 lb media	½ gal./100 lb media	¼ gal./100 lb media
—polish	2 in. over mass	½ gal./100 lb media	½ gal./100 lb media
Speed of rotation	18 rpm	6 rpm	
Frequency vibration		2700	2700
Amplitude		maximum	maximum
Delicate Wire-like Parts—Thin Fragile Steel Stampings			
Media-to-parts ratio		6 to 8 to 1	
Media level		80%	
Media type		Fused abrasives Ceramic shapes	
Media size		7/32 x 1/8 in. (No. 5)	
Water—cut		½ gal./100 lb media	
—polish		1 gal./100 lb media	
Speed of rotation		4 rpm	
Amplitude		minimum	
Frequency vibration		maximum 2700	
Compound—cut		Cushioning abrasive	
—polish		Burnishing soap 2 oz/gal. water	
Heavy cut			
Media-to-parts ratio			2 to 1
Media level			80%
Media type			Large ceramic-bonded alum. oxide triangles
Water			¼ gal/100 lb media
Amplitude			maximum
Frequency vibration			maximum

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Hughes Numerical Controls can help keep your up-time extremely high. In fact, customers report down-time of as little as 2% of productive time after thousands of hours in operation. (Ask any company that uses Hughes Numerical Controls.*) The reason: HUGHES RELIABILITY. Hughes' electronic engineering know-how combines transistorized circuitry, modular construction and photo-electric tape readers to achieve true RELIABILITY. This means lower operating costs, greater productivity and higher profits to you. If you can't afford down-time, get the facts. Find out more about RELIABLE Hughes Numerical Controls. Write, wire teletype (INGL 4117) or call direct: Hughes Industrial Control Systems, Dept. No. 92-21, P. O. Box 90904, Los Angeles 9, California.

List of companies in your area using Hughes Numerical Controls supplied on request.

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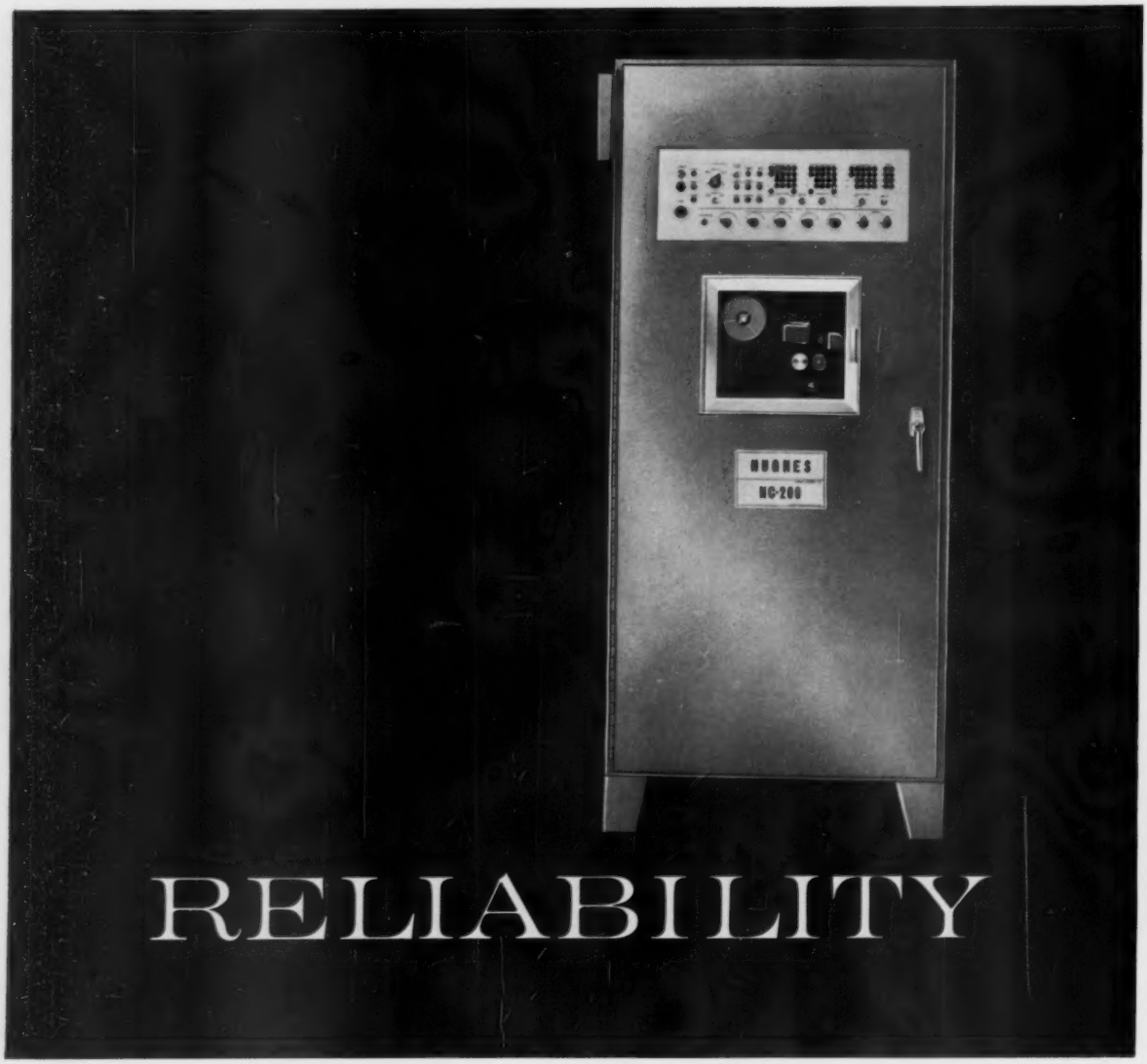
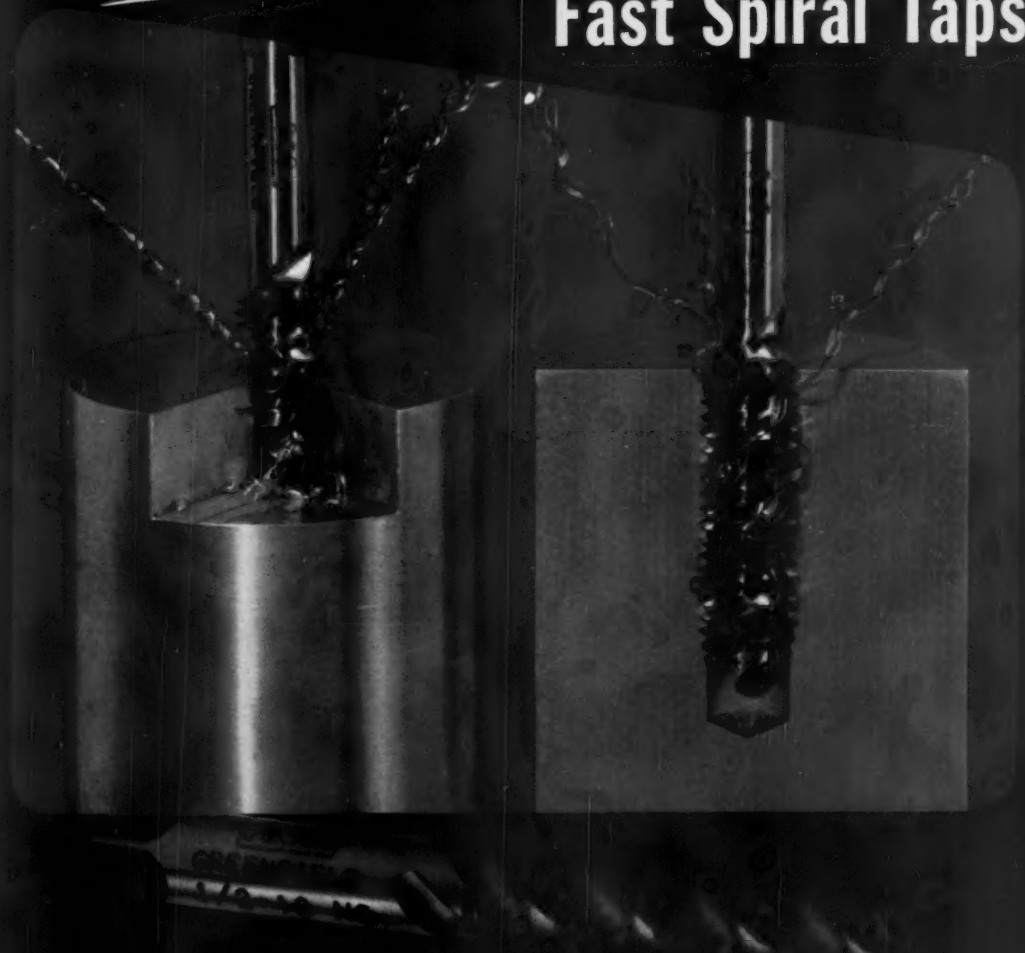


LIGHTNING®

Fast Spiral Taps



Spiral fluted taps have long been noted for their efficiency in ejecting chips from blind holes by virtue of their "lifting" action which reduces friction and minimizes the tendency of chips to clog in the flutes. They are especially recommended for use in ductile and other free cutting material.

LIGHTNING® taps, which is the GREENFIELD version of the ***"fast spiral"*** development in tap flutes, emphasizes this lifting action to a marked degree. Its ability to span slots or other interruptions and to tap relatively deep holes in a wide variety of materials has resulted in a lightning spread of popularity among tap users. When you buy ***fast spiral taps,*** specify LIGHTNING®

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GREENFIELD TAP & DIE GREENFIELD, MASS.

New, Lightweight Face Shield Offers Full Protection

Where full facial protection is required, you'll find the new AO H9 Face Shield is a cool, comfortable answer. Its lightweight plastic headgear weighs only 3¾ oz., can be preset in ⅛ increments from size 6 to 8¼. When set, entire face shield lifts easily on and off.

A deep spark deflector of lacquer-coated, vulcanized fiber keeps particles from entering top of shield, protects forehead. Automatic friction joints require no turning or adjustment. Vinyl foam sweatband provides a cool, comfortable bearing surface resting on the forehead. It absorbs perspiration, preventing it from carrying particles into eyes. Adhesive-backed, it is easy and economical to replace.

This new H9 Headgear accommodates all AO 'H' Series windows—clear or green acetate, aluminized acetate, 24 mesh steel screen, and 283-1 Kool-Vent window. Patented slots permit expansion and contraction, reduce possibility of warping and distortion. For details and prices, call your AO Safety Products Representative or write for folder.

Your Surest Protection . . . AO SURE-GUARD Products

American Optical COMPANY

SAFETY PRODUCTS DIVISION • SOUTHBRIDGE, MASSACHUSETTS

Talking Shop

Cover Point

IF YOU ARE already very familiar with numerical control you may have spotted a special meaning in the design of the cover for this issue. If you haven't spotted it, you might care to take another look.

We have set aside several copies of the valuable and popular book "Numerical Control for Metalworking Manufacturing" and we'll send a copy of it to each of the first six people writing us and telling the full meaning of the design. Send your letter to Talking Shop Editor, AM/MM, 330 W 42nd St, New York 36, N.Y. This "contest" will close automatically once we begin distribution of reprints of the Special Report, "How to Prove the Profit in Numerical Control" because we'll explain the meaning in this column—and in the reprint.

Mixing Shortcut

FOR MIXING electrode coating compounds, A O Smith Corp, makes use of a turntable on which bags of the different components are arranged in order. For each different type of electrode, a sheet-metal templet is attached to the face of the weight scale and carries a single witness mark at a code number representing each component. The scale man then progressively indexes the turntable, pours in material from the bag opposite him until the scale pointer reaches the mark for that component, and punches a record on a batch card. When the table has made one revolution, the batch is complete and there is a printed record of the exact composition.

Titanium Carbide

SOME FIELD REPORTS have reached us on experience with the new titanium carbide toolbits developed by Ford (*AM/MM*—Mar 23 '59, p125) and now produced under license by Vascoloy-Ramet (*AM/MM*—Aug 21 '61 p135).

One interrupted cut on a square mounting bracket involves facing a 4-in. dia. on a 1045 carbon steel. The New Britain automatic runs at 929 rpm giving a speed of 980 sfpm at the start of the cut. Feed is 0.005 ipr and the depth of cut is 0.060 in. on the roughing cut and 0.020 in. on the finishing cut.

The VR-65 tools are reported to have finished 160 pieces with two corners of one insert, compared to 20 to 25 pieces with tungsten carbides (C-5, C-7, and C-8 grades had been tried).

Another case is a boring operation on a 4340 steel forging at 825 sfpm, 0.007 ipr feed, and depth of cut of 1/64 in. The bore is 5 3/16 in. dia. and 7½ in. long. With a soluble oil coolant, the average tool life is 18 to 20 bores per edge.

This Is Music?

A MOBILE is one of those ultramodern pieces of sculpture consisting of assorted abstract shapes suspended on wire. Recently a mobile was used as an instrument in a performance of "Music With Sculpture" by the American Wind Symphony.

The mobile (suspended above the orchestra) is made of 56 pieces of 22-gage Type 304 stainless supplied by Jones & Laughlin. When the score calls for "tones" from the mobile members of the orchestra point their instruments at it and blow. The wind creates motion and the result is a jingle—or perhaps a jangle. Possibly even music.

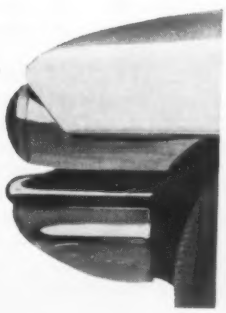
Blind Inspector

A GENERAL-PURPOSE AIR GAGE for use by a blind inspector has been developed for a company near Philadelphia by Standard Gage. The undersize, in tolerance and oversize tolerance zones are identified by three different tone buzzers, to permit classification of work by sound. A simple switch reverses the sound pattern to retain the relative sound pattern if the gage is changed from ID to OD operations.

Trucks?

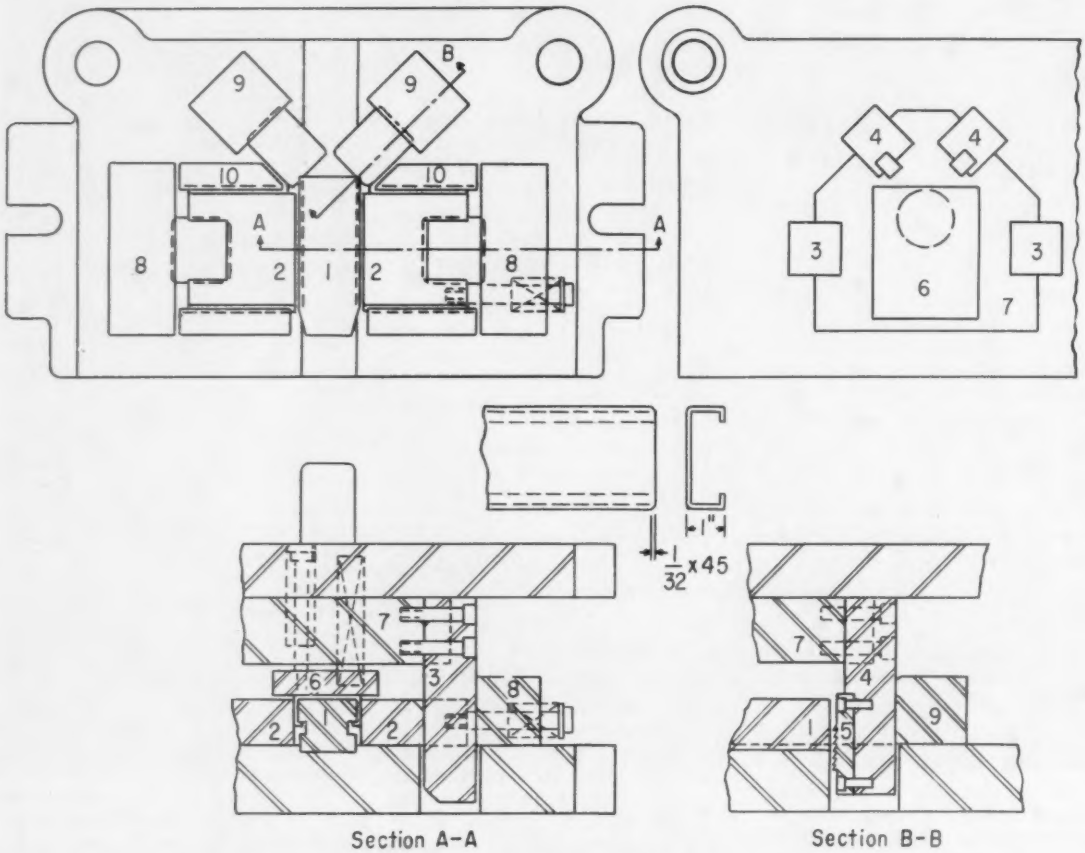
TWO LIMOUSINES would seem to be on the verge of being classed as trucks in Ontario. The provincial maximum width for cars is 80 in. Anything over this width must carry truck clearance lights—green in front and red in the rear—between sunrise and sunset.

The big cars are the Cadillac Series 75 and the Chrysler Imperial. Both companies are reported ready to add the clearance lights, if necessary, to export models.



Practical Ideas

Die Performs Broaching Operation



It was required to cut a 1/32 X 45° chamfer on both sides of a 1-in. deep rolled shape made from 16-gage CRS. Production was fairly high, and it was imperative that the chamfers be square with the top face, even though the sides might have sprung out of square during the cut-off operation.

To do the job as fast as possible and with maximum accuracy we made up the die shown above to cut the chamfers by broaching. The work is loaded over a stake *1* and pushed against an end stop (not shown). As the ram starts down, the stripper plate *6* clamps the top of the work against the stake, while the cam drivers *3* activate the cams *2* to clamp the sides of the work against the stake. At this point the broaching cutters *5* attached to holders *4* start to cut and continue down until the last tooth clears the work and the chamfer is cut to size. On the up stroke, the side cams are retracted from the work by spring pressure and the work is unloaded by sliding it off the stake.

Other details shown are: *7*, the retainer for the cam drivers and broach holders; *8*, backup blocks for the cam drivers; *9*, backup blocks for the broach holders; and *10*, the gibs for the side cams.

It will be noted that the broach inserts are set off center in the holders. This is done to permit us to exchange the inserts from one side to the other when they become dull, thus doubling the life between grinds. This is possible because only a relatively small part of the tooth width contacts the work. With an ample supply of cutting oil supplied to the broaches, results have been highly satisfactory in speed and accuracy.

B Packer, Shaker Hgts, Ohio

Steady Bushing Guides Shaft

Removing the center hole from the end of a long, slender shaft after turning to size often presents some difficulty, particularly when you don't want to go to the trouble of setting up a steadyrest. The job is made easy, however, by the arrangement shown here.

It consists of a piece of bronze barstock held in a drill chuck in the tailstock and bored to a close fit for the end of the shaft. A slot, ½ in. wide, is milled across it to about the centerline or a little less, and an oil hole is drilled near the front end.

The tailstock is advanced until the end of the work is well into the slot

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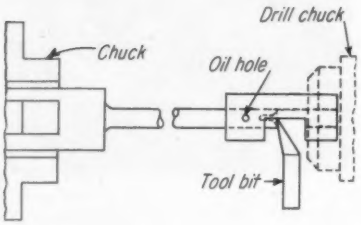
of the bushing where it can be reached by the tool. When facing to length or removing a center hole, it may be necessary to advance the tailstock spindle after a few cuts to prevent the tool from striking the edge of the bushing slot.

The same bushing can also be used to support work when chamfering or radiusing the end, as well as for grooving and short threading.

John S Valentime, Hartford, Conn

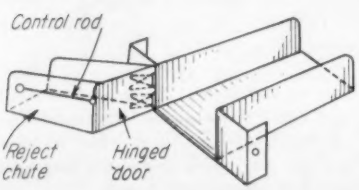


Diverter Separates Rejects

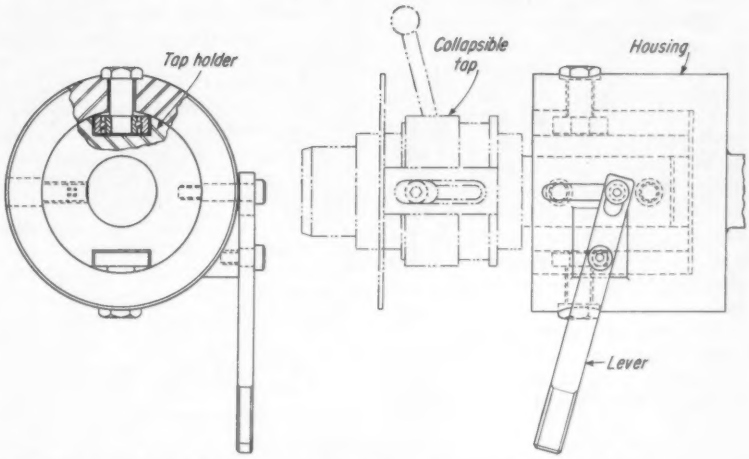
We have to cut four 12-ft lengths of vinyl and rubber bicycle pedal tread at one time to various lengths. This is done with a knife die in a power press. At each stroke we cut four pieces which are ejected by an air jet into a chute and fall into a tote box. The first and last pieces cut off are always rejects because of improper form or incorrect size, and we wanted to avoid the trouble of sorting these out from the good pieces.

We solved the problem by installing a secondary chute on the side of the press, equipped with a hinged diverter door manually controlled by a rod. Now, just before the first and last cuts are made, the operator pushes the rod to open the diverter door and close the regular chute, allowing the parts to fall into a scrap box. This has increased production on the pedal assembly line and saved the work of two men formerly employed as sorters.

Fred Lettino, LIC, NY



Special Holder Feeds Collapsible Taps



When using collapsible taps and self-opening dieheads on a hand screw machine, our operators had considerable trouble in feeding the tool into the work by operating the turret manually. Unless this is done evenly and at the right speed, threads will be loose or damaged and, with the high-pressure components we make, high quality threads are extremely important.

To overcome this trouble we built this special holder. The housing is made from a piece of round stock turned down to form a shank that fits the hole in the turret. The opposite end is bored a sliding fit for the tap holder. Two holes are drilled and tapped opposite each other, and into these we insert a screw which has been turned down at the end to fit the ID of a standard ball or roller bearing. The length of these screws must be such that they hold the bearings far enough away that they can roll freely without rubbing on the ID of the housing.

The tap holder is turned from round stock to be a sliding fit in the housing, and is bored to accommodate the shank of the tap or diehead. Two keyways are milled down the full length, diametrically opposite, and of a width to make a sliding fit on the OD of the bearings. Two holes are tapped into the holder for headless setscrews that secure the tap, and access holes for these are drilled into the housing.

The actuating lever pivots on a shoulder screw that is tapped into a pad welded to the side of the housing, and an elongated slot is milled through the housing to accommodate a shoulder screw.

In practice, the operator brings the turret up close to the work, hold it in that position, and starts the threading tool by pulling back on the lever. Once the tool is properly engaged, it will feed into the work by pulling the holder forward, riding on the ball bearings, until the stop is reached and the tool opens or collapses. It is then retracted by pushing the lever forward and is ready for the next operation.

R Schafer, Racine, Wis

Bolt Repairs Heating Element

When an electric heating element breaks it is not always necessary to replace it if the rest of it is still in good shape. Take a 10-32 machine screw and make a cut with a hacksaw from the end right down to the head. Push the screw through the mica former, place a washer on the other side, then insert the broken ends of the resistance wire or ribbon in the slot. Add another washer, and tighten down a nut to make a firm connection.

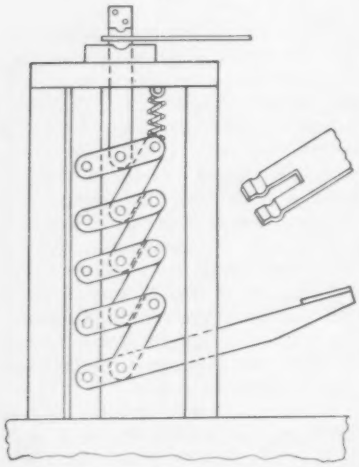
Robert Micals, Freehold, NJ

Practical Ideas

Linkage Operates Foot Press

At various times we have to make up a small number of forked steel bars of different lengths, in some of which we have to form a crimp across the fork, as shown. Quantities did not justify setting up a regular press, and we decided that the crimping job would provide a good fill-in job for operators of machines that were down for repair or adjustment. As the operators are girls, we had to devise a method that would not require a great deal of effort, and we came up with the machine shown here.

We built a heavy wooden table with a T-bar at the back to which we pinned a series of pairs of free-swinging links. Single links connect



the ends of each pair to the center point of the next pair. A treadle provides the operating power, and a return spring holds the links, and the punch, in the up position. To the center of the top link is pinned a vertical bar that passes through the table and the die block and carries two forming punches, one on each side. The bar is slightly thinner than the opening of the fork and thus acts as a guide and stop for the work.

Considerable pressure is obtained on the punches with only light pressure on the treadle because, in addition to the mechanical advantage provided by the treadle itself, each pair of links almost doubles the power applied to it by the preceding pair.

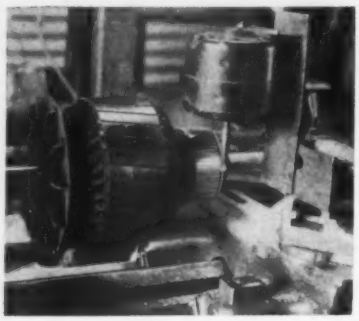
L Kasper, Philadelphia, Pa

Vertical Motor Simplifies Armature Undercutting

After undercutting commutators for many years with the cutter spindle in the horizontal position, which required a vertical slide for adjusting the depth of slot, I made up this vertical undercutter from an old fan motor and two pieces of scrap iron. I found it to be much better because the adjustment for depth of cut and for various diameters of commutators is made by the lathe cross-slide. With the old horizontal type, a large commutator that took the full swing of the lathe required an equally high vertical slide to bring the motor over the top of the armature, and there was always a problem with backlash due to gravity, as well as a loss of rigidity.

The new setup allows the operator to sit down and watch the precise alignment of the cutter with the slot very conveniently. Previously he had to stoop over, and his view was obstructed by the body of the motor. I index the armature with the lathe spindle in back gear, turning the idler pulley slowly by hand, which gives a high ratio and fine adjustment. A 1050 to 1200-rpm motor with a 5/16-in. dia cutter is a good combination. The cutter spindle is secured to the motor shaft by a setscrew and must be perfectly concentric.

H Landauer, Tampa, Fla



If you're willing to share your ideas,
To help other men in their need,
With a practical kind of assistance,
You'll be doing a really good deed.

It's a wonderful thing to help others,
To counsel, and guide, and direct,
And point out a simple solution—
But you'll be the one to collect.

SIMPLE GAGE CHECKS FLATNESS

Was the winning entry in the Aug 7, 1961 issue.

The $25 prize is awarded to:
Ernest Goulet, E Haven, Conn

AN EXTRA $25 will be paid for the best Practical Idea in each issue of American Machinist/Metalworking Manufacturing. All items appearing on the Practical Ideas pages are eligible. In case of a tie, duplicate prizes will be awarded.

PAYMENT—will be made as soon as tabulation is completed, and is in addition to the regular rate for the item published.

JUDGES—are a group of American Machinist/Metalworking Manufacturing readers who select articles they prefer in a particular issue. The group changes entirely with each issue and thus represents a true cross-section of readers. Their decision is accepted by the editors, without reservation or bias, as final in each case.

REQUIREMENTS—Items must be submitted by the originator on an exclusive basis. Do not worry about your shortcomings as an author, draftsman, or photographer—every item will be edited in accordance with AM/MM standards, and readers will judge only the finished product—in terms of its usefulness to them.

WHO MAY ENTER—Anyone may enter except employees of McGraw-Hill Publishing Co Inc, and those of advertising agencies or departments. Suggest to your employees that they submit ideas.

HOW TO ENTER—Send all entries to: Practical Ideas Editor, American Machinist/Metalworking Manufacturing, 330 W 42nd St, New York 36, NY. Please make sure that your name and address are included.

Names in the News

Saginaw Bearing Co, Detroit, has elected **M C Patterson** president and treasurer. Mr Patterson, former Dodge Division general manager, and Chrysler Corp vice president, succeeds **William Agricola,** son of the firm's founder, who will retire February 1.

Sterling Electric Motors Inc, Los Angeles, has appointed **Alfred E Grazen** president and general manager. He was previously executive vice president of Platecraft of America and a partner in Emco Industries. These Buffalo corporations are engaged in development of special products and materials in the electro-chemical field.

Singleton Co, Cleveland designer and manufacturer of plating barrel equipment, has promoted **Mark A McGinnis** from sales manager to vice president, sales.

A & C Engineering Co, Warren, Mich, has named **E W Bell** general manager in charge of engineering, sales, and manufacturing of Hydra-Lock arbors, chucks, and gages.

Baldwin-Lima-Hamilton Corp has appointed **Edward J Doolittle** product sales manager, cutting and forming equipment, for the Industrial Equipment Division at Eddystone, Pa. He was previously sales engineer working out of the Pittsburgh District Office

Snow Manufacturing Co, Chicago, has named **Tom Owen** executive vice president. He was formerly head of the thread gage and tap division of Size Control Co. Snow builds high-speed automatic tapping and drilling machines with automatic fixturing.

United Aircraft Corp has appointed **Charles T Roelke** assistant general manager of the **Hamilton Standard Division.** He has most recently been serving as assistant general manager of Pratt & Whitney Aircraft Division's Florida Research and Development Center.

Avis Industrial Corp, Detroit, has appointed **Carl J Demrick** vice president in charge of manufacturing for all of the Industrial Divisions. Mr

American Welding & Manufacturing Co, Warren, Ohio, has appointed **John P Lynn** general manager of the Industrial Products Division. Mr Lynn has been manager of manufacturing for the firm since 1956

Demrick is president of the Hurd Lock Division in Almont, Mich, and will continue in that capacity. He was formerly president of Chrysler Corp's Amplex Division and vice president in charge of manufacturing of the Plymouth Division.

Garrett Corp, Los Angeles, has named **Jack Lewis** vice president, manufacturing. He was formerly manufacturing director. **J J O'Brien,** manager of Garrett's AiResearch Manufacturing Division of Arizona has been named vice president of the corporation.

John Hassall Inc, Westbury, Long Island, NY, manufacturer of cold headed fasteners, has elected **Edward F Karnes** vice president, sales. He moves up from the post of sales manager.

Shaw Process Development Corp, a division of Avnet Electronics Corp, Port Washington, NY, has appointed **Irwin J Lubalin** executive vice president. He was also named a vice president of British Industries Corp, a division of Avnet. Mr Lubalin was formerly general manager of Shaw Process, licensor for the precision ceramic-mold casting technique.

Link-Belt Co, Chicago, has named **Leslie J Carson** director of engineering. He has been general manager of the Colmar, Pa, plant

Volkert Stampings Inc, Queens Village, NY, has appointed **Ernest L Gerdts** production and development engineer

OBITUARY

Howard J Daly, 64, vice president and director of **Norton Co,** Worcester, Mass, died Oct 7. He was general manager of Norton's electric furnace plants at Chippawa, Ont; Cap-de-la-Madeleine, Que; and Huntsville, Ala. •

Part: Insert for car-door knob

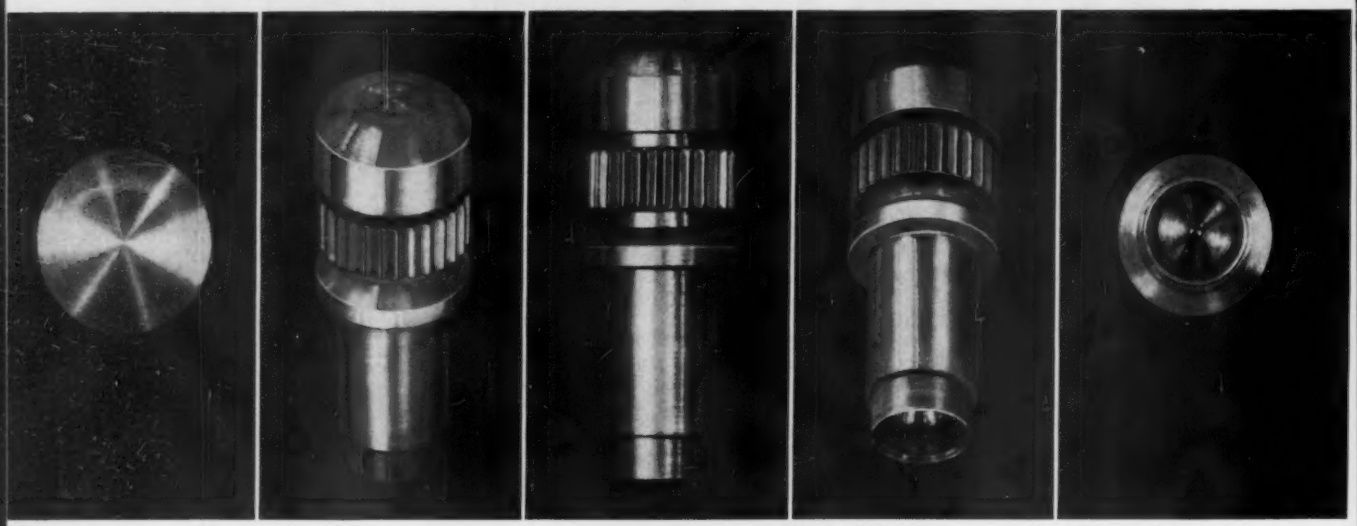
Screw Stock: 13/32 in. BETH-LED round, cold drawn

Chip Removal: 41 per cent

Cutting Speed: 284 SFM—up 29 per cent*

Production Rate: 1920 pieces/hour—increased by 33 per cent*

*over the control stock: C1213 non-leaded steel



BETH LED

Beth-Led machines fast without sacrificing tool life. Chip control is excellent. Machined finish is tops. The addition of lead to the steel is carefully controlled to achieve the most uniform distribution possible throughout the section. Your bar automatics will eat it up.

Available through non-integrated cold-drawers

Plan now to cut *your* production costs with Beth-Led. It's readily available . . . cold-finished as distributed by non-integrated cold drawers . . . or hot rolled, as produced by Bethlehem.

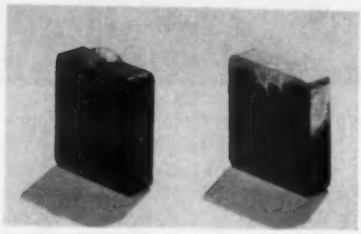
Steel

for Strength
. . . Economy
. . . Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



Carbide Additive Gives Cleaner Blanks, Improves Braze Strength

Patented carbide additive called Unibraze provides carbide tools, inserts and blanks that are thoroughly clean and ready to use with no sandblasting, grinding or chemical cleaning necessary. Blanks treated with Unibraze also are said to exhibit up to 30% greater braze strength, lower working temperatures by 200 to 500 F and to improve the flow of brazing al'oy over and into all the carbide surfaces. This last is illustrated by the Unibraze treated blank on the right in the photograph above.

Unimet Carbides, 435 W Ontario St, Chicago 10, Ill

MORE DATA? Circle 84, inside back cover

Aerosol Color-Coding Compound Adheres To Metals Through Grease

New aerosol compound for coding materials with different colors will adhere tightly to metals through grease or dirt without loss of brightness.

The compounds, which are packaged in 16-oz aerosol cans, are available in black, red, yellow, orange, blue, gray, brown, green, gold, copper and aluminum.

Perc E Harms Co, Northfield, Ill

MORE DATA? Circle 85, inside back cover

Paint, Tar, Sludge Stripper Sold With Immersion Basket

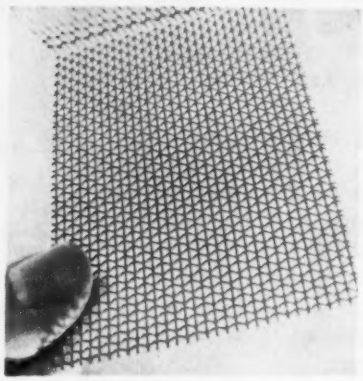
Strip-all, a new concentrated cleaner will strip carbon, sludge, varnish, also paint and tar, from all types of metal parts without harming the metal itself.

The non-flammable solution is available in quart, 1½-gallon and 6-gallon sized kits that consist of the cleaner and an immersion basket.

Parts to be cleaned are placed in the basket and lowered into the fluid. After a few minutes the rust is loosened enough to be rinsed off with water.

Stewart-Hall Chemical Corp, 222 Washington St, Mount Vernon, NY

MORE DATA? Circle 86, inside back cover



Stainless Alloy Wire Cloth Can Be Heat Treated, Deep Drawn

Wire cloth woven of high temperature stainless alloy NS-A286 is designed for fabrication of parts operating in a 600 to 1000 F range. Parts made of this wire cloth can be hardened after forming or fabricating and can be drawn deeper than parts made with hard temper wire. Principal elements of the alloy are chromium, 15%; nickel, 25.25%; titanium, 2.10%, and manganese, 1.60%. Tensile strength as drawn and annealed is 103,500 psi but after 16 hr at 1350 F this increases to 176,000 psi. Reduction of 15% increases tensile strength to 122,000 and results in a tensile of 190,000 psi after heat treating.

Reynolds Div, National-Standard Co, Dixon Ill

MORE DATA? Circle 87, inside back cover

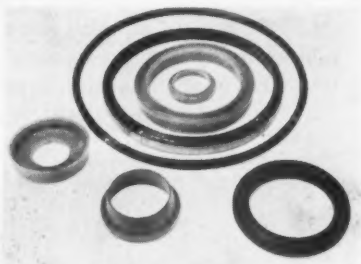
Pure Cobalt Strip With Good Ductility Offered Commercially

Pure cobalt strip with good ductility and workability is commerically available for the first time in thicknesses ranging from 0.005 to 0.025 in. and in widths of ¼ to 6 in. Produced by rolling directly from pure cobalt powder, the 99.9%-pure strip has a tensile strength of 165,000 psi when cold rolled to a 25% reduction. Elongation of this strip is 0.5% and Rockwell hardness (45T) is 85. Direct rolling of the strip is done in three steps; first, cobalt powder is cold compacted in a vertical rolling mill to form green strip 6 in. wide, 0.060 in. thick and 70 to 80% dense. This green strip is sintered in a hydrogen atmosphere and then hot rolled into the finished strip.

A chemical analysis of the finished strip reveals a composition of cobalt, 99.9%; nickel, 0.10%; copper, 0.005%; iron, 0.018%; sulphur, 0.004%; and carbon, 0.014%. Base price is $4.40 per lb, with $25 being the minimum order.

Sherritt Gordon Mines Ltd, 25 King St West, Toronto 1, Canada

MORE DATA? Circle 88, inside back cover



Urethane Seals Withstand 10,000 Psi With No Backup Rings

Hydraulic seals and packings made of Disogrin, the company's urethane elastomer, have a tensile strength of over 5000 psi at break which enables them to withstand pressures of 3000 to 10,000 psi and higher with no backup rings. Specially developed chamfered sealing lip is said to give leakproof sealing, even at low pressures and simple assembly of seal bearing components without special tools or fixtures. The seals which can operate over a variety of temperatures ranging from –40 to 225 F are compatible with most hydraulic fluids and show high abrasion, tear and wear resistance.

Hardness of the material as used is 90 on the Shore A durometer scale but despite this resilience is good; 550% elongation at break.

The seals are available in the form of U-cups, O-rings, cup packings, flange packings, rod wipers, and washers.

Disogrin Ind, Div of Pellon Corp, 510 S Fulton Ave, Mt Vernon, NY

MORE DATA? Circle 89, inside back cover

THIS CINCINNATI®
shears heavy plate

Paragon Bridge & Steel Co., Novi, Mich., cuts costs as it cuts heavy plate with this Cincinnati Shear:

Operators cut production time with rapid, easy gaging and adjustment; no need for changing knife clearance to cut different thicknesses of metal.

The Cincinnati Shear also permits square shearing, notching, and slitting operations.

This machine can trim an edge to one-half the thickness of a sheet or plate. Furthermore, longer knife life is obtained from extra-size, four-edge knives.

Whether you're considering a mechanical or hydraulic shear, the broad Cincinnati line offers you maximum advantages for your plate shearing requirements. Write for your copy of a Cincinnati Shear catalog.

Shapers / Shears / Press Brakes

THE CINCINNATI SHAPER CO.

Cincinnati 11, Ohio, U.S.A.

United Kingdom: The Cincinnati Shaper Co., Ltd., Glasgow, Scotland

Courtesy Paragon Bridge & Steel Co., Novi, Mich.

La Salle Tellurium Steel Is Fastest Machining Bar Stock

Leaded steel with tellurium added is said to make the fastest machining stock ever. (*AM/MM* Oct16, '61 p118) Speeds over 600 sfm were reached in tests on the new steel in machining spark plug shells. This was 3½ times the machining speed of the standard screw machine steel, B1112. Tool wear during the tests was said to be normal even though cutting feeds were increased 1/3 over normal.

Called La Led X, it is produced in carbon steel stock at $15 a ton more than ordinary stock price and in alloy steel stock at an increase of $20 a ton.

The La Salle Steel Co, 1420 160 St, Hammond, Ind

MORE DATA? Circle 90, inside back cover

Kennametal Offers Semi-Finished Tungsten Carbide Boring Bars

Semi-finished boring bars have solid tungsten carbide shanks with heads of machinable steel for mounting various types of cutting tools. The rigid shank K-bars are available in 10 sizes ranging from 7/16 to 2½ in. dia and from 7⅝ to 28¼ in. overall length. Heads made of 28 to 32 Rh C steel are ¾ to 4⅝ in. dia and 1 15/16 to 9⅝ in. long. Bars of ¾-in. shank diameter and larger have coolant holes drilled longitudinally through their center.

Kennametal, Inc, Latrobe, Pa

MORE DATA? Circle 91, inside back cover

Synthane Copper-Clad Laminate Gives 2 to 4-lb Hot Peel Strength

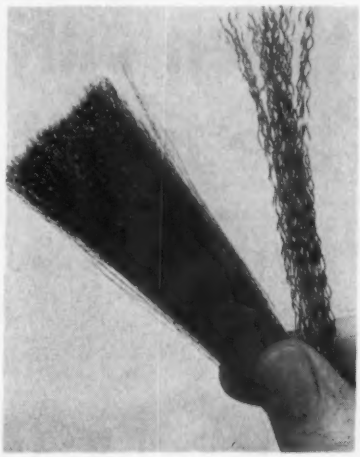
Grade G-10R, a new copper-clad laminate for printed circuitry, meets or exceeds NEMA and MIL specs for room temperature peel strength and, in addition, has a hot peel strength of 2 to 4 lbs per inch of width.

Developed to meet the needs of printed circuit users for a high hot peel strength board, Grade G-10R allows soldering at 500 F with a reduction in the number of wire failures caused by curved wires pulling off the board.

The laminate uses no structural adhesives and is available in sheets of 36 by 36 or 36 by 48 in. in the usual copper foil thicknesses.

Synthane Corp, Oaks, Pa

MORE DATA? Circle 92, inside back cover



RANGE OF MULTIPLE STRAND WIRE sizes has been extended down to 0.005 in. Previously the company could supply wire down to only 0.008 in. This new size gives the company a range from 0.005 through 0.018 in. in brush wire which can be supplied with exact wire counts ranging from 50 to 2000 wire per strand—Dept RDT National-Standard Co, Niles, Mich

MORE DATA? Circle 93, inside back cover

American Smelting Introduces Self-Lubricating Bearing Bronze

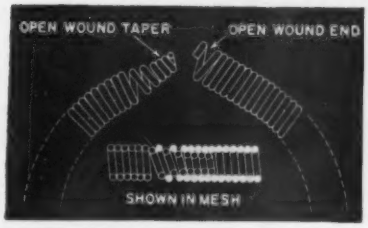
New continuous-cast bearing alloy, designated Asarcon 230, is a high-lead bronze designed for self-lubricating bushings, bearings or seals.

The alloy is free of blowholes, shrinks, voids, pits, and inclusions and is available in a range of diameters up to 5 in. in standard length of 13 in. cut to specification. It may also be ordered in solid or hollow bar and in sizes and shapes close to those required for the finished component.

Typical physical properties of—230 are: Tensile strength 16, 300 psi; yield strength 9,000 psi; elongation (2 in.) 10; Brinnell hardness 30, and machineability, (compared with free cutting brass) over 100.

American Smelting and Refining Co, 120 Broadway, New York 5 NY

MORE DATA? Circle 94, inside back cover

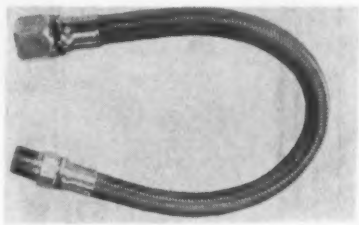


Garter Springs Have Interlaced End Connection For Constant OD

Patented end connection of these new garter springs is said to maintain the same OD as the rest of the spring across the connection. Called Interlock, it involves interlacing the coils to prevent distortion of the connection. This is also said to improve flexibility at the joint and give high resistance to lateral stress. Recommended for use as oil seals, diaphragms, drive belts, brush holders, clutch segments, and O-rings, the springs can give uniform tension throughout 360 degrees, and maintain precise circumferential dimensions required for tight assemblies.

Associated Spring Corp, Bristol, Conn

MORE DATA? Circle 95, inside back cover

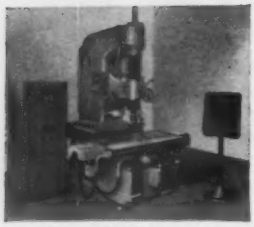


Teflon-Lined Hose Has Metal Overbraiding

Trimflex hose, manufactured from a specially formulated inner core of 100% virgin TFE 6 Teflon, is extruded on the company's machines to exacting dimensions. Special braiding equipment applies the tightly woven stainless or bronze over-braiding which is reported to provide unusual resistance to flexing, pressure, and vibration fatigue. The Teflon inner core will withstand temperatures from –65 to + 500 F. Trimflex end fittings are available either permanently swaged to the hose or detachable and reusable; latter can be either factory or field installed. Fittings are stocked in stainless and bronze; other metals, alloys, and configurations can be supplied on special order.

Timely Technical Products Inc, 100 Pine St, Verona, NJ •

MORE DATA? Circle 96, inside back cover



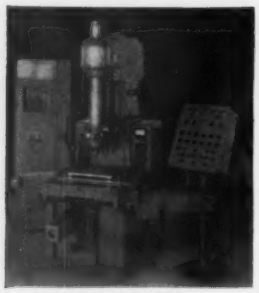
W. B. Knight Jig Borers

Wiedematic Turret Punch Presses

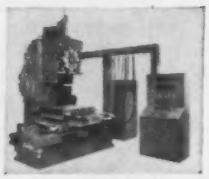
American Tool Works Co. Boring & Drilling Machines

When only the finest will do...

De Vlieg Jigmills

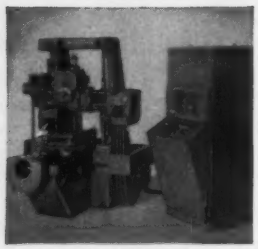


Moore Jig Borers



Avey Turret Drills

Bullard Spacer Tables (Retrofit Kits)



SIP Jig Borers

Burgmaster Turret Drills

specify

SPERRY NUMERICAL CONTROL

FOR **PRECISION • RELIABILITY • PRODUCTIVITY**

SIMPLICITY—There are fewer components in a Sperry Control, thanks to the pneumatic block reader that does away with complex memories or shift registers. Fewer components mean higher reliability, and easier maintenance.

ACCURACY—Independent linear measuring scales provide extremely high accuracy unaffected by age or wear. The initial accuracy built into the machine remains constant throughout its life.

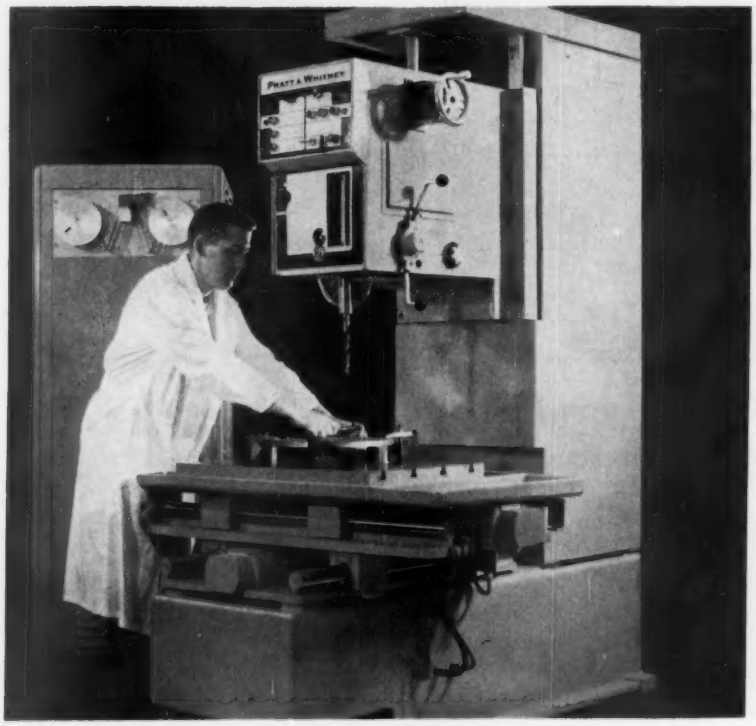
RELIABILITY—Sperry Controls contain almost 33% less components than conventional designs and by this fact alone are considerably more reliable. Machines equipped with Sperry Controls do not use vulnerable ball bearing leadscrews, thus simplifying machine maintenance too.

SPEED — The Sperry block reader can read one two coordinate position and auxiliary commands in 1/10 of a second. This fact combined with the high performance of hydraulic actuators, provides exceptionally high positioning speeds. Traverse speeds of 700"-1000" per minute are being achieved on certain machines.

Further information can be had from machine tool builders and dealers — or write us direct for illustrated brochure. A powerful and dramatic 15-minute sound movie on the Sperry Numerical Control is also available — ask to see it.

SPERRY

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.
P.O. Box 710 • Montreal 3, Que.



Pratt & Whitney N/C Drilling Machine Sells For $8595 Complete With 5-Year Warranty

This numerically controlled drilling machine is offered with a money-back guarantee if it fails to reduce the buyer's drilling costs in 90 days and, in addition, has a 5-year warranty on defective parts and workmanship; claimed to be a first for N/C machines.

Called the Tape-O-Matic, the single-spindle machine has transistorized control of the X and Y axes, simultaneous positioning of the table and carriage, full floating zero, and continuous monitoring and feedback of position.

Control circuit features

The transistorized controls, which operate without relays or stopping switches, use signals from standard tape for simultaneous positioning of the table and carriage at rapid traverse speeds up to 300 ipm. Position locating accuracy is ±0.0005 in. and repeatability is ±0.0005 in. The controls are not affected by room temperatures up to 130 F and line voltage changes of ±10%. In addition, frequency variations of ±10% do not interfere with drill operation.

Full floating zero feature of the machine means that either or both axes can be zeroed at any point in the table so that parts can be clamped anywhere on the table and the zero set automatically at the required point.

Feedback and monitoring of the positioning is accomplished through a table quantizer disc. As this disc rotates with the lead screw, printed lines on the disc interrupt a beam of light. The interruption of these light beams produces digital pulses, each representing 0.001 in. and these are fed back and compared to the input data stored from the tape. When the feedback pulses equal the input pulses the machine is at the set point and an in-position light goes on. A tool change code also can be set up that stops the machine cycling and advises the operator by means of a light on the control panel that the drill needs changing.

Designed for quick setups

Setting up the machine is eased because of several design features built into the system:

- Three jog speeds; 300, 8, or 0.5 ipm can be selected for setups.
- Since this system will recognize negative numbers plus or minus signs can be used when processing the tape.
- Plus sign and leading zeroes (those in front of the first significant digit) can be eliminated from the tape.
- If dimensions on either axis are unchanged from one-operation to the next, these dimensions can be deleted when preparing the tape.
- All controls are located in one panel on the front of the machine.

The machine is offered in 1½ or 3-hp models with a 20 by 30-in. table size and a table travel of 20 by 15 in. For maintenance-free operation this table is mounted on permanently lubricated circulating ball bushing ways. Vertical adjustment of the head is 14 in., quill travel is 6½ in., and the spindle has a No. 3 Morse bore.

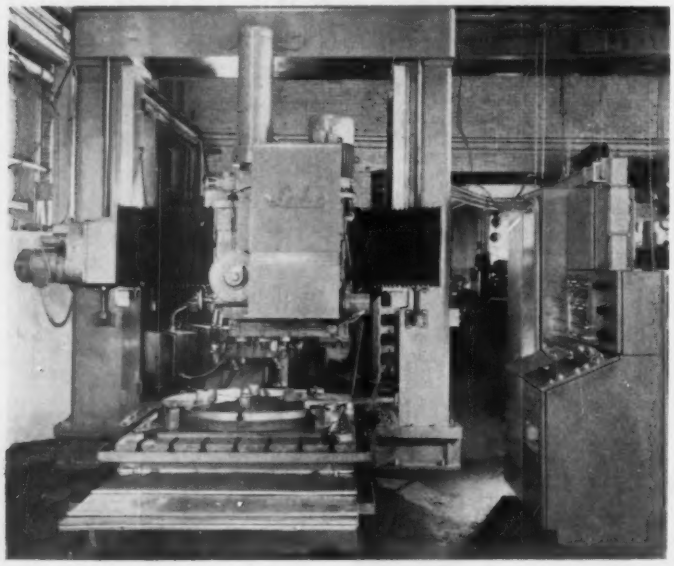
Spindle speeds are infinitely variable in two ranges; 300 to 2000 rpm and 150 to 1000 rpm, and spindle feeds can be selected at 0.004, 0.006 and 0.009 ipr on machines with power feed .

Standard equipment offered for the $8,595 price includes, along with those features already mentioned; all motors, fused disconnect switch, automatic tape rewind, sensitive lever drill head with limit switch at the top of spindle travel to activate positioning, and a special wrench for spindle depth stop nuts.

Among the many optional features and accessories offered at extra cost are: power down feed, three-digit operation number readout, coolant pump and reservoir, automatic cycling equipment, tape punch process preparation units, quick-change drill chuck, tapping attachment, and riser support block sets.

Pratt & Whitney Co, Inc, West Hartford 1, Conn

MORE DATA? Circle 51, inside back cover



Lahr N/C Heavy Duty Planer Type Milling Machine Uses Tape Program for Tool Change

This heavy-duty planer-type tape controlled drilling and milling machine equipped with an automatic tool changer can work on parts that measure 5 by 6 by 5 ft high. The illustrated machine will eventually handle 275 different parts programmed for machining in lots of 2 to 100 pieces.

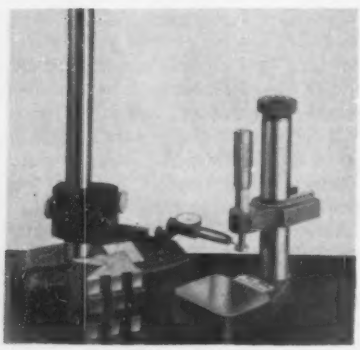
The machine's 6-in. diameter spindle is driven by a 15-hp motor through gear trains for both speed and feed. Spindle travel is 21 in. and it has 20 speeds from 25 to 600 rpm and 30 feeds from 0.0043 to 0.2450 ipr. With positive lead tapping the machine can produce all leads from 4 to 44 threads per in.

The 14 or 20-position tool changer has a 3-in capacity and takes Scully Jones type adapters for presetting depths.

Numerical control system for this machine gives complete control over 3 axes and all auxiliary functions. Its program includes positioning, (x and y axes) spindle speed, feed rate, approach depth, cutting depth, (z axis) mode of operation (drill, tap, or mill) and tool selection. Positioning of the table over its 72-in. travel and the head over its 48-in. travel are done simultaneously at 150 ipm.

Lahr Machine & Tool Corp, 3400 Maplewood Ave, Toledo 10, Ohio

MORE DATA? Circle 52, inside back cover



B & S Economy Measuring Instruments Check Heights to 6 in.

Economy line of Hite-Mikes furnished with a 1-in micrometer head a 1-in. dial indicator or a ½-in. dial indicator can be used for measuring and transferring heights and sizes up to 6 inches.

The units consist of a 1-in high base with chrome-plated and lapped top surfaces and three lapped pads on the underside. A 6-in high column holds 5 1-in tubular gage blocks.

The micrometer head or dial indicators are held in a 1-in. thick yoke that has a chrome-plated and lapped slides. This 2-in long yoke can be inserted over any block on the column and may be positioned through 360 degrees.

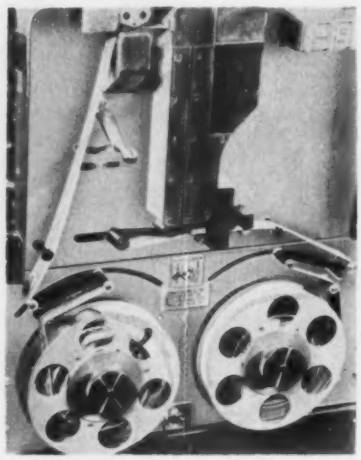
Micrometer heads models (shown) have slant line graduations and read in 0.001-in increments. A 1-in thick disk located at the spindle end can be used for setting heights over or under and can be removed so that the Hite mike can be used as a bench micrometer.

Dial indicator models have graduations in 0.001 over a 1 in. range or in 0.0001 in. over a ½-in. range. 0.001-in. size has 1 count hand and 0.0001-in size has two count hands showing 0.010 and 0.10 in. of movement.

All these models can be set by loosening a knurled clamp nut at the top of the column, sliding the yoke over the gage block nearest the required height and tightening the clamp nut.

Brown & Sharpe Mfg Co, Providence 1, RI

MORE DATA? Circle 53, inside back cover



System Stores Data on Paper Tape At 1000 Characters a Second

Omnidata tape system can store information at the rate of 1,000 characters a second on paper tape and in addition, can read all kinds of tape without needing constant opacity.

The new technique stores information on the surface of the tape insead of punching holes in it. In this way the recording apparatus never touches the tape but rather writes on the tape with electrostatic discharges from a set of electrodes. The tape is then passed through a bath of dry powder ink which adheres to the charged area. After fixing, the tape can be read optically without physical contact.

The other half of the system is the Omni-Data reader which can handle all types of tapes, punched or printed, opaque or transparent because it uses chopped reflected light as the sensing technique.

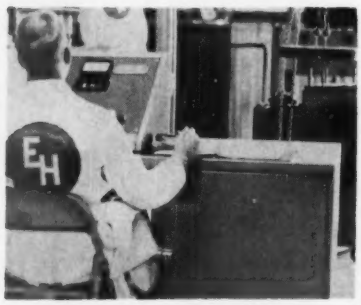
In this system light is focused with a double convex lens into a narrow beam at an angle to the tape. A series of light pipes, one for each channel and sprocket, is fixed in position over the tape near the line of light and

at the proper angle so that the reflected light hits the rod ends and is directed through a rotating chopper to the sensing photodiodes. In this way darker printed areas or holes in the tape are sensed because they reflect less light.

Units using this principle are available that will read all standard tape with up to 8 data channels and a sprocket channel in either strip, loop, or reel tape. Speeds are up to 100 ips. Bi-directional reading and start-stop on each character at speeds up to 100 characters a second are other features of the units.

Omnitronics, Inc, Subs of Borg Warner Corp, 511 Broad St, Phila, Pa

MORE DATA? Circle 54, inside back cover



Electro-Hydraulic Machine Gives 500,000-psi Explosion on 110 V

Newly developed electrohydrau'ic capacitor discharge machine that works from 110 V ac or dc house current is reportedly able to fabricate practically any metal or combination of metals by a number of tecahniques to tolerances of 0.0005 in.

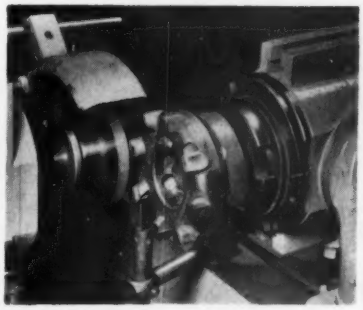
Techniques that the machine is claimed to use include electronic welding, locking, bonding, or laminating, die embossing, shaping, flanging up to 90 degrees,, blanking, flaring, beading, piercing, and plating.

Source of power is a bank of capacitors charged by a transformer rectifier combination. This power unit gives a rate of rise in current of several hundred thousand amperes per microsecond. When released the current creates a non-chemical explosion between two electrodes that can cause pressure buildups as high as 400,000 to 500,000 psi. and channel temperatures to 25,000 C.

Shown is a 15,000-joule machine that is large enough (about the size of an office desk) to form internally-expanded tubular parts to a 10-in. diameter and 4-in. long flat sheet parts to 196 sq in.

Electro-Hydraulics, Inc, Dallas, Tex

MORE DATA? Circle 55, inside back cover



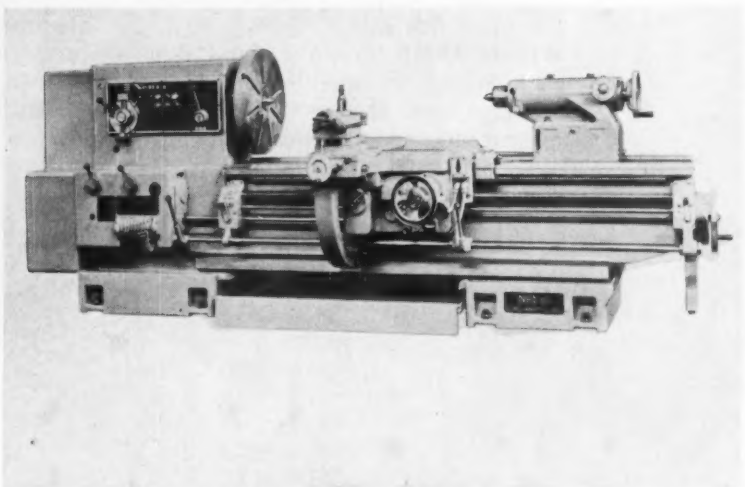
New Bonded Diamond Wheels Grind Carbide Wet or Dry

Norton has developed a new resinoid bond for diamond wheels which makes it possible for one wheel to grind carbide either wet or dry more economically than with wheels previously available. The B-56 bonded wheel performed substantially better in tests on wet grinding operations than other wheels designated for wet grinding only. And, wheels made with the same bond, when used on dry grinding operations, outperformed those wheels designed for dry grinding only. Increased wheel life of up to 30% was achieved.

Norton wheels made with the new bond are available in all sizes and shapes. In general, the new bond does not require a change in wheel specification for doing the same operation as former wheels. Prices are the same as wheels made with other resinoid bonds.

Norton Co, Worcester 6, Mass

MORE DATA? Circle 56, inside back cover



Nebel Heavy-Duty Extension Bed Gap Lathe Has Wider Gap Power-Traversed Tailstock

Swing of the heavy duty extension bed gap lathe has been increased in the gap to 49½ in. and a new tailstock now features two direct reading dials for measuring tailstock traverse.

This heavy duty tailstock moves under power from the longitudinal feed mechanism by engaging the carriage through an interlock. A heavy duty thrust lock engaging a rack located in the upper bed prevents the tailstock from moving on the bedway under heavy loads.

This model also features 18 gear-driven speeds up to 1500 rpm. A heavy duty quick change box gives 60 different feeds from 0.0007 to 0.195 ipr and 60 thread changes from 1 to 72 threads per inch, including standard pipe threads. The 25 hp lathe has 146 inches of bearing surface, box girth bed design, and totally enclosed gearing.

Two new options are available: (1) A two speed tailstock traverse giving slower feed rate for drilling and reaming with standard feed rate permitting quick withdrawal. Speed selection is by plunger control on the tailstock wheel.

(2) A revolving tailstock with a locking device to lock the quill for drilling or tapping. This tailstock, available with two speed feed has a special device to compensate for heat generated in the workpiece during operation.

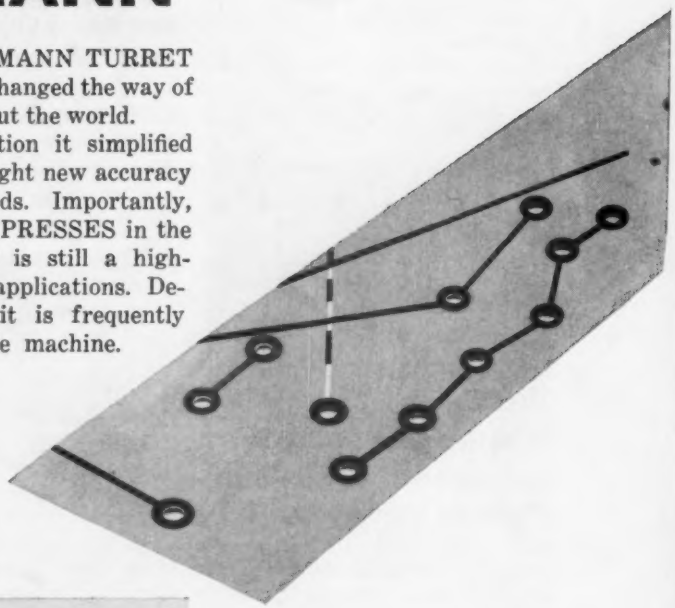
Nebel Machine Tool Corp, Dept 10, 103 South Cooper Ave, Cincinnati 15, Ohio

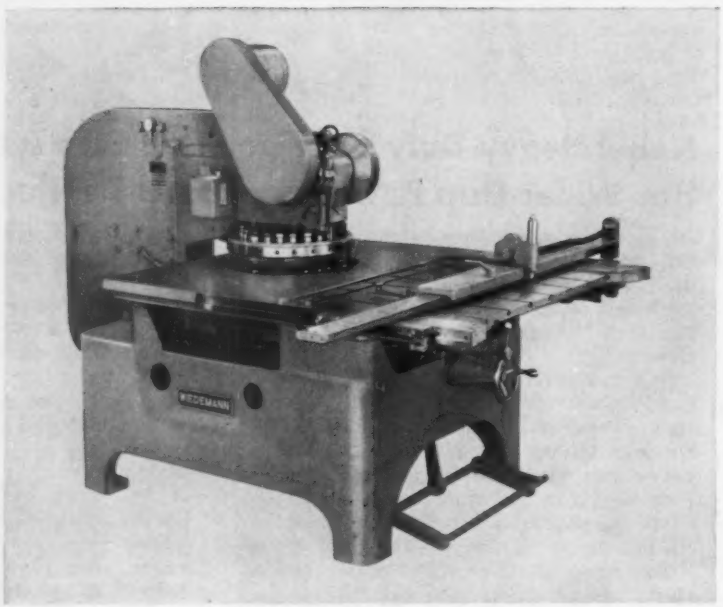
MORE DATA? Circle 57, inside back cover

THE OLD NEW LOOK AT WIEDEMANN

In the '50's, the RA-41P WIEDEMANN TURRET PUNCH PRESS and its template changed the way of life for metal fabricators throughout the world.

In installation after installation it simplified and increased production and brought new accuracy to piercing operations of all kinds. Importantly, like other fine TURRET PUNCH PRESSES in the WIEDEMANN line, the RA-41P is still a high-performance machine for many applications. Depending upon the requirement, it is frequently recommended as the most suitable machine.





Fifteen-ton RA-41P TURRET PUNCH PRESS for 28" x 40" sheets and available in 36" x 48" Table size.

Ask for information on the free time-analysis of your work. This will prove to you the amazing savings possible by using the WIEDEMANN METHOD instead of the complexity of methods commonly utilized for piercing sheet metal. This study will show you the floor-to-floor time to position and punch your work on a WIEDEMANN PRESS, the machine most applicable to your work and each individual tool required.

THE *New* NEW LOOK AT WIEDEMANN

Today's WIEDEMATIC provides a high-speed, completely tape-controlled method to produce vastly more work with even less preparation and with a high degree of reliability and productivity. This method for piercing in very low to medium quantities obsoletes the template and other setup problems . . . replaces highly-skilled craftsmen with self-trained operators . . . produces at a *consistent* high rate.

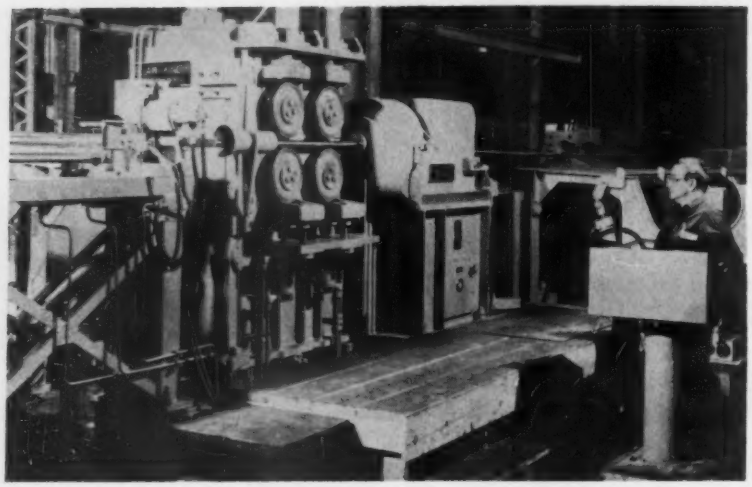
The WIEDEMATICS are deep-throat 15, 30, 50, 100 and 150-ton machines with table sizes from 30" x 48" up to 12' x 18'.

WIEDEMATIC A-15 tape-controlled TURRET PUNCH PRESS, 15-ton 30- station for 30" x 48" sheets and available for 30" x 72".

ASK FOR INFORMATION

WIEDEMANN MACHINE COMPANY
DEPT. AM-11 • GULPH ROAD • KING OF PRUSSIA, PA.

WIEDEMANN



High Speed Centerless Bar and Tube Turning Machine Gives 60-fpm Feed Rates

This centerless bar and tube turning machine, designed especially for use with ceramic and carbide tooling is equipped for feed rates up to 30 fpm.

A single cutter head that takes mechanically clamped tools gives eight cutting edge changes without requiring a resetting of the cutters. In addition, the company's patented torque chipper is supplemented by a new pressure support collet that gives better rigidity at the point of turning. A series of pressure loaded steadying rolls on both input and output feed devices gives additional rigidity. With the fully automatic tables that are supplied with the machine, an operator can run a complete load of bars in an end-to-end, nonstop operation without touching the machine.

The turners are offered in sizes that will handle from ⅜ to 6 in. diameter stock and larger sizes can be designed on request.

Auxiliary coil handling equipment is offered that allows shaving or turning of coiled wire.

Blaw Knox Co, 300 Sixth Ave, Pittsburgh 22, Pa

MORE DATA? Circle 67, inside back cover

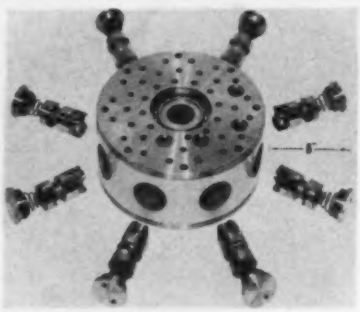
Unit Performs Stress Relieving, AC/DC Welding Simultaneously

Compact portable machine called the UniPak is available in two basic models, one equipped with six individual UniPak resistance heating control units, the other with three. Both can be used for ac/dc welding and for stress relieving, simultaneously, if desired. The six-unit machine can be used to stress relieve as many as 12 welds at one time in pipe up to 3 in. in diameter and up to six welds in 6-in. pipe. Unit's primary stress relieving applications are in treating thin-walled alloy pipe. Since resistance heating is used, maximum pipe wall thickness for programmed heating is ½ in.

Stripped-down models for stress relieving only are also available.

Electric Arc Inc, 153 Jelliff Ave, Newark 8, NJ

MORE DATA? Circle 68, inside back cover



Low-Speed Servo Motor Extends Control Horizons

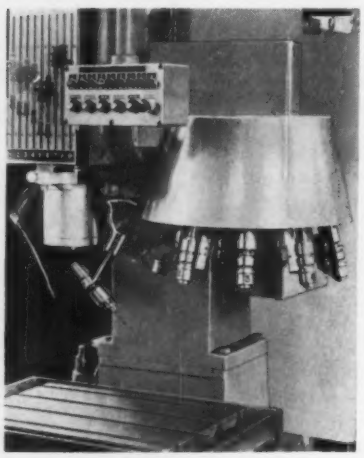
Acradrive 22 cu-in. hydraulic motor is designed for applications which require a control motor of extreme stiffness, high torque-to-inertia ratio, extremely fast response, and wide speed range with ultra-slow speed limits.

The motor operates at a recommended maximum pressure of 500 psi with an effective speed range under servo control of 1/60,000 rpm to 500 rpm. It delivers 3.52 in.-lb/psi torque at full capacity with an efficiency of 98% and reverses 100 rpm rotation in 0.0015 sec. Rotor advances only 0.0306 of a revolution after the signal to reverse is given. Because of its high torque-to-inertia ratio and sensitive response the motor may be connected directly to a leadscrew or driveshaft. By eliminating need for intermediate gearing, it does away with this source of error in conventional drives.

Unit measures about 12 in. across by 6 in. thick, and weighs 138 lb. List price is $2000.

Cincinnati Milling Machine Co, Cimtrol Div, Cincinnati, Ohio

MORE DATA? Circle 69, inside back cover



Tape Controlled Tool Changer Completes Change in 5 Seconds

Accessory equipment for the Edlund-Matic Model 2N drilling and tapping machine, this automatic tool changer makes tool changes in 5 seconds under tape control.

The unit can carry up to 9 different cutting tools that are manually fitted with adapters and seated in the individual storage positions in a rotating matrix. Adapters are clamped in the nose of the spindle automatically. When a tool change is signalled by tape, two pneumatically controlled fingers grip an adapter in the spindle and it is released by air pressure control. The fingers then seat the adapter and tool in the original storage position and the matrix rotates until the next desired tool comes into position where the fingers can grip it.

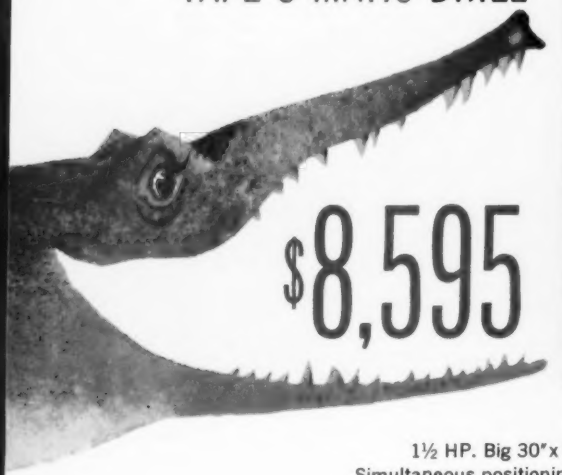
Edlund Machinery Co, Dept A Cortland, NY

MORE DATA? Circle 70 inside back cover

CIRCLE 329 READER SERVICE CARD ►

WE'RE PUTTING OUR MONEY WHERE OUR MOUTH IS!

WITH A 90-DAY MONEY-BACK GUARANTEE ON THE NEW PRATT & WHITNEY TAPE-O-MATIC DRILL



$8,595

1½ HP. Big 30"x 20" table.
Simultaneous positioning of both axes.
(3 HP. optional at extra cost.)

NOW! FOR THE FIRST TIME A NUMERICALLY CONTROLLED DRILL FOR ONLY $8,595 GUARANTEED TO REDUCE YOUR DRILLING COSTS

At last . . . a drill with the finest, transistorized, numerical-control system available for only $8,595 . . . because P&W brings mass production to the machine tool industry for the first time . . . yet maintains the 100-year tradition of P&W quality.

The TAPE-O-MATIC enables **you** to benefit from numerical control . . . to gain a vitally-needed, important competitive edge.

WE BELIEVE IN THIS NEW DRILL SO STRONGLY THAT WE OFFER:

1 90-DAY, MONEY-BACK GUARANTEE. If by 90 days after purchase, this drill has not reduced your drilling costs, return it for refund, less transportation costs.

2 5-YEAR WARRANTY. We fully warrant the TAPE-O-MATIC drill against defective parts and workmanship for 5 years from date of purchase.

3 UNIQUE TERMS. You can buy TAPE-O-MATIC using our exclusive Trade-in Plan. You can purchase the drill outright, lease it, or lease it with option to buy. ONE PER CENT CASH DISCOUNT FOR PAYMENT IN 10 DAYS.

Call collect . . . your local Pratt & Whitney representative, now! Or write to: Paul N. Stanton, Vice President Marketing; Pratt & Whitney Co., Inc.; Charter Oak Blvd.; West Hartford, Conn.

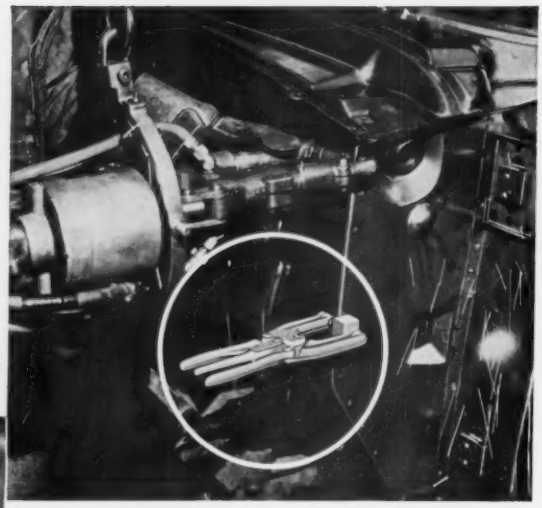
PRATT & WHITNEY
A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY
Machine Tools / Cutting Tools / Gages

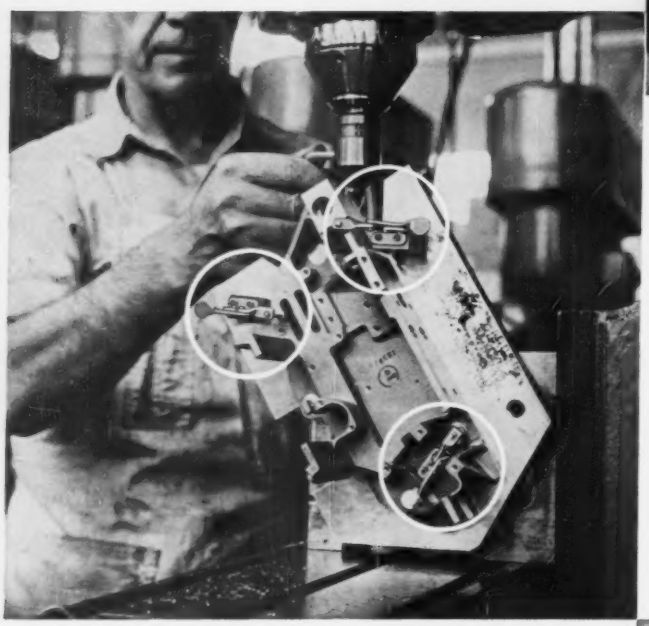
HEADQUARTERS FOR AMERICA'S WAR AGAINST OBSOLESCENCE

No. 2 of a series

Look what clamps are doing!

Practical uses of Wespo Toggle Clamps and Pliers that may suggest ways you can save

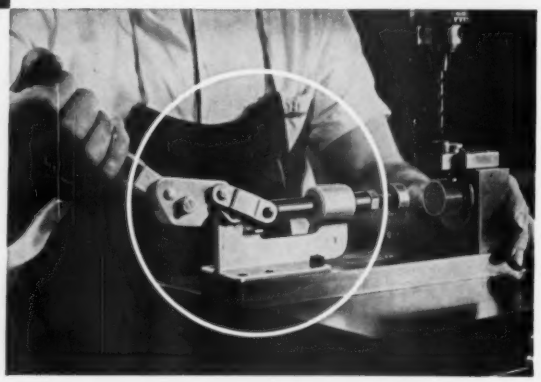




Low Cost Wespo Toggle Pliers have a myriad of uses in assembling operations—as portable clamps, clamping where space is limited, or overhead clamping. Their usefulness as portable clamps is demonstrated in this auto body welding operation. The plier shown has the Wespo "Quick-Trigger" release which permits one hand operation. All Wespo toggle pliers are engineered for fast, positive locking with a minimum amount of hand pressure. They are available in numerous styles and jaw sizes.

This Wespo Push-Pull Clamp serves as a simple fixture to hold a knurled ring securely during the drilling operation. The adjustable spindle is fitted with a large pad which mates with the inside diameter of the ring, holding it securely. Wespo makes a variety of push-pull clamps for use where smooth, horizontal clamping action is required. All models feature the "better 3-ways" Wespo design and are ruggedly built to stand hard use. Some models have locking action in both the "push" and "pull" positions.

Miniature Toggle Clamps, only 2½" overall!—These small, light weight Wespo Series 50 Clamps can do a hundred different jobs on small fixtures such as the one shown above. Their compact design and smooth operation also make them useful in the assembly of small parts, in electronic wiring and soldering operations, on fixtures where space is limited... anywhere a small, rugged clamp is needed. Maximum holding pressure is 35 lbs. Available with a horizontal or vertical mounting base; adjustable spindle.



NEW 16-PAGE WESPO CLAMP CATALOG!

More than 80 different models and sizes of clamps are described to help you quickly select the proper clamp for every clamping job.

Ask your Wespo Distributor for a free copy today.

WESPO

DIVISION OF VLIER ENGINEERING CORPORATION
A SUBSIDIARY OF BARRY WRIGHT CORPORATION
26935 W. Seven Mile Rd., Detroit 19, Michigan
Formerly West Point Manufacturing Company

Micro-Chip is all alike!

It's consistent. Like dimes fresh from the mint...parts made of Micro-Chip are all alike. Kaiser Aluminum's new 2011-T3 Screw Machine Stock consistently delivers small chips...fast machining...minimum tool resetting...uniform machinability throughout each bar, from bar to bar, lot to lot. Call your Kaiser Aluminum Distributor for "Micro-Chip."

KAISER ALUMINUM

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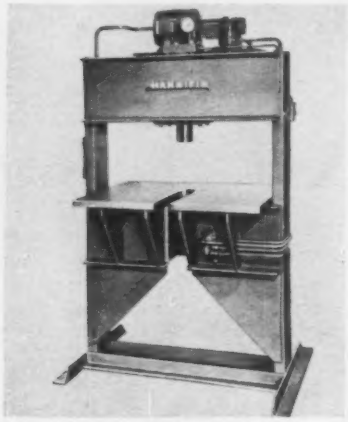
MICRO-CHIP

ASK YOUR KAISER ALUMINUM DISTRIBUTOR FOR YOUR 1961 ALLOY COLOR CODE CHART • NEW LEADERSHIP IN THE WORLD OF ALUMINUM



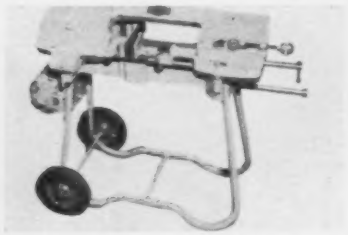
Utility Press Line Features Component Selection Concept

Hydraulic ram or guided platen industrial presses can be designed for specialized production jobs by simply selecting the proper combination of standard components—frames, working forces, speeds, circuits, controls, and power sources—to meet preset requirements.

Series I have structural steel frames which meet NMTBA deflection standards. The 25, 50, 75, and 100-ton capacity units are offered in both ram and guided platen models with choice of 24x24 or 36x24-in. die areas. Seven power sources are available to provide a wide range of press speeds. Seven electrical control systems are available as well as manual control and the manufacturer's Sensitive Pressure control.

Hannifin Co, Dept 518 S Wolf Rd, Des Plaines, Ill

MORE DATA? Circle 75, inside back cover



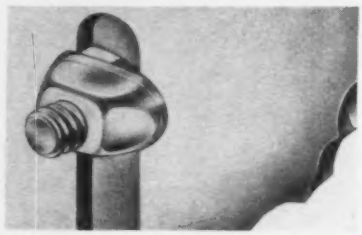
Power Metal Cutting Bandsaw Furnished in Portable Model

Capacity of this Excel model is 3 x 6 in. overall, 40 in. long, 12 in. wide. The ½-in.-wide blade is 60 in. long. Automatic shut-off switch stops the motor when cut is completed. Adjustable hydraulic cutting feed control with graduated dial sets feed rate according to cross section or type of material. The workholding vise adjusts to cut any angle up to 45 degrees.

Two 8-in.-dia rubber ball bearing wheels provide means for moving the saw to the job; it can be guided into position by a retractable handle that extends 12 in.

Covel Manufacturing Co, Benton Harbor, Mich

MORE DATA, Circle 76, inside back cover



One-Piece Nylon Fastener Is Quarter-Turn Type

Type NY-Q quick-release fastener is a wedge, or keystone shape. The quarter-turn engagement is halted by stops molded into the central base. Unit is offered in No. 6-8-10 sizes. The No. 6 and 8 will take sheet thicknesses from 0.050 in. up; the No. 10 size from 0.060 up. The fastener can also be used on curved surfaces where the radius is 4 in. or more. It is not recommended, however, for applications where operating temperatures will exceed 250 F.

Available also is the ESNA Type LHA4972, a clip-on self-locking fastener for such aircraft applications as attachment of flooring, sound proofing, and fairings. It can also be used for many other types of sheet metal or fiber glass assemblies for missile and electronic end-use as long as the 0.020-in. thickness of the clip can be tolerated between the mating surfaces. Made of carbon steel, it is currently available in size 10-32 and other sizes are being designed.

Elastic Stop Nut Corp of America, 2330 Vauxhall Rd, Union, NJ

MORE DATA? Circle 77, inside back cover

Progressive Welder's Flarer Trims, Squares Chamfers, Flares Tube Ends Automatically

Said to be the first of its kind to accurately and uniformly trim, square, chamfer, and flare standard aluminum, mild steel, stainless and other tubing, this machine is designed for handling tubes with ⅜ to 1½ in. OD.

The machine uses a two-station operation for flaring; station one trims and squares the tube end, chamfering both ID and OD, and station two flares the tube. The tubes are clamped in position during all operations.

Controls are provided to vary the speed of the dc drive motor and the duration of the flaring cycle to accommodate the individual characteristics of different metals. They are preset in the panel and are adjustable during operation.

Progressive Welder & Machine Co, 915 Oakland Ave, Pontiac, Mich

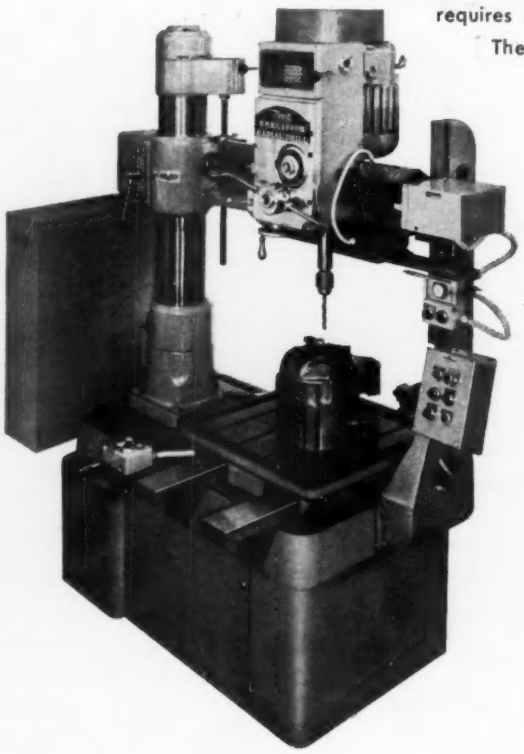
MORE DATA? Circle 78, inside back cover

SINGER*

NUMERICAL CONTROL

BUY THE COMPLETE PACKAGE...

FOR THE O.E.M. . . . SINGER Numerical Control . . . the most direct approach to point-to-point positioning . . . offers speed, capacity, versatility, a high degree of accuracy . . . and is available at a low initial investment. The system is sold as a package, complete and ready for installation, including the tape reader. It requires only the measuring bars to suit the specific machine. The SINGER system offers a high degree of accuracy, for drilling, jig boring or milling . . . ±.001 inches on a work table and up to 40 inches of travel.



...OR THE COMPONENTS

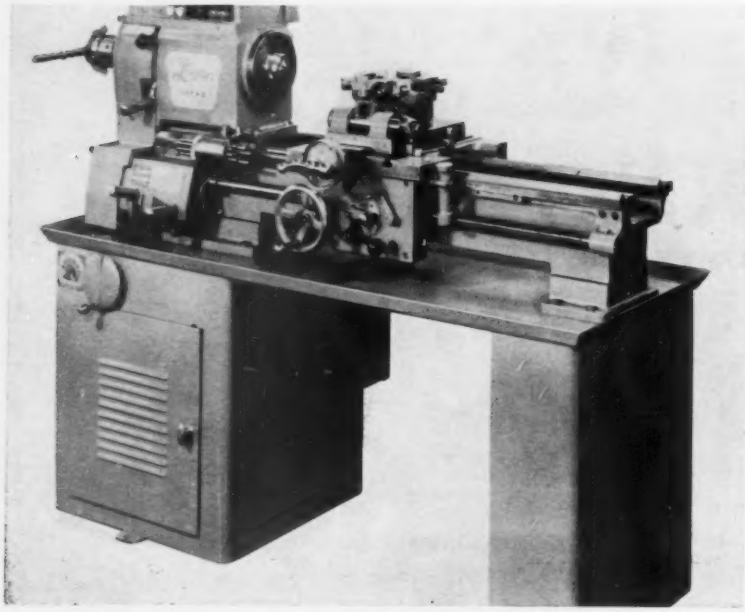
For the buyer who wants to acquaint himself with the advantages of automatic positioning, rather than buy a complete package, the SINGER system is ideal. Because of SINGER'S modular design, a machine can be furnished with the automatic positioning system only. At a later date, tape control can be readily added with no sacrifice of the original investment. It is important to know, too, that all modules and motors are designed, serviced and built by Diehl Manufacturing Company, a SINGER subsidiary. Call or write for an appointment at the address below.

Shown here is SINGER Numerical Control applied to the new Veetmatic Precision Drilling Machine. This electrically-operated system provides more economical operation at greater accuracies than conventional layout drilling procedures.

Diehl† **DIEHL MANUFACTURING COMPANY**

SUBSIDIARY OF THE SINGER MANUFACTURING COMPANY
Finderne Plant, Somerville, New Jersey
Telephone: Randolph 5-2200

*A Trademark of THE SINGER MANUFACTURING COMPANY
†A Trademark of THE DIEHL MANUFACTURING COMPANY



EIGHT STATION TURRET CHUCKING MACHINE features precision headstock and spindle, flame hardened bed and ball bearing variable speed drive. Turret is also mounted on a precision pre-loaded sealed ball bearing to assure accuracy and rigidity—*Logan Engineering Co, 4901 West Lawrence Ave, Chicago 30, Ill* MORE DATA? Circle 79, inside back cover

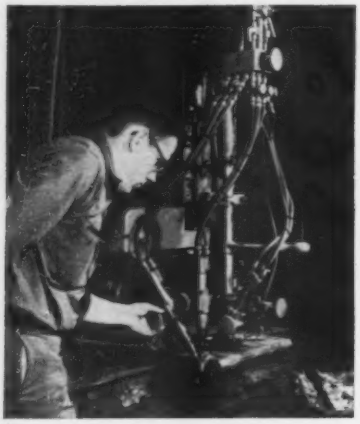


Plate Edge Preparation Unit Keeps Constant Cutting Distance

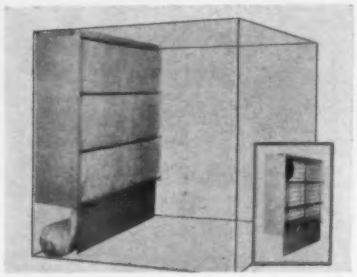
With standard machine cutting torches using acetylene, natural gas or propane, a new plate edge preparation unit can cut standard straight edges as well as single bevels, double bevels, or bevels with a nose.

Cutting accuracy is said to be exceptional because the nozzles float freely as a plate riding wheel moves over the work surface. This feature maintains constant cutting distance regardless of the shape of the work surface. The free-floating feature can be locked out at the end of a cut so that the nozzles will not drop onto the work when the wheel moves off the edge of the work.

The 45-in. high attachment can be installed on a flame-planer type bridge, an OM-48 side-beam carriage, or the CM-37 portable machine carriage.

Linde Div, Union Carbide Corp, 275 Park Ave, New York 17, NY

MORE DATA? Circle 80, inside back cover



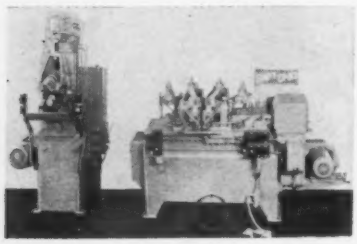
Overspray Filter Developed For Paint Spraying

Paintstop, a highly economical system for eliminating overspray, consists of a pull-up type media available in standard or heavy-duty type rolls that cover complete filter section in one piece. The used media is cut off, folded, and disposed of. There are no metal frames, and use of water, pumps, valves, or nozzles is eliminated.

System is built in various sizes which readily adapt themselves to standard dry booths now in use. They can also be used in other standard booths or in tunnel design booths.

E F Vilter Co, 3525 N Palmer St, Milwaukee 12, Wis

MORE DATA? Circle 81, inside back cover

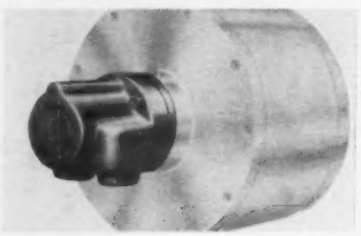


Two Welding, Trimming Machines Incorporate Improved Tooling

These production welding and flash trimming machines for processing automotive ring gears are available with new and improved tooling. Model 25 flash welder (right) is rated at 150 kva and is fully automatic in operation. Model 0 oscillating flash trimmer (left) is hydraulically operated and is also fully automatic. The flash welder clamp fixtures are designed to align both ends of the ring in a single motion. Tooling on the trimmer is adjustable over a range of sizes.

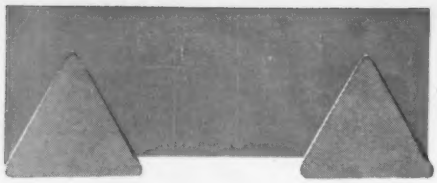
Swift Ohio Corp, Kenton, Ohio

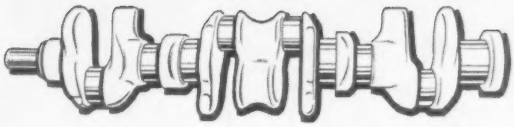
MORE DATA? Circle 82, inside back cover



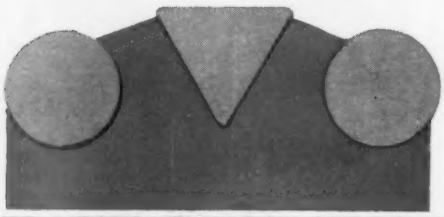
SPINDLE SPEEDS UP TO 4,000 RPM are possible with the new double bearing air inlet which has a special inlet seal that adjusts itself automatically through working pressure. Available on the company's rotating air cylinders of 3, 4½, 6, and 8 in. bore sizes, the new air inlet, designated the RM4, features a smaller shaft for increased speed and a compact design to eliminate vibration at high speeds—*The S-P Manufacturing Corp, 30201 Aurora Rd, Cleveland 39, Ohio*

MORE DATA, Circle 83, inside back cover

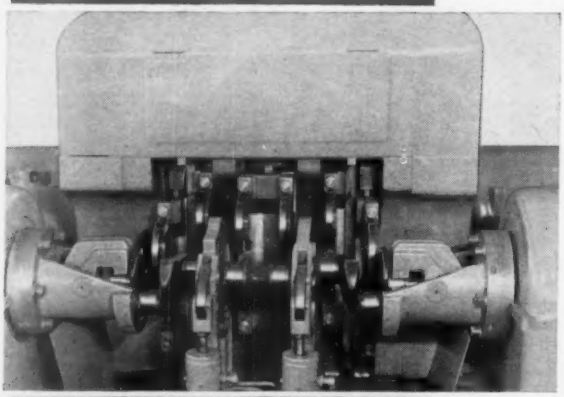




QUICK-CHANGE VERSATILITY!



Yours since 1955 with WICKES highly versatile MP-4 cartridge-type Crankshaft lathe.



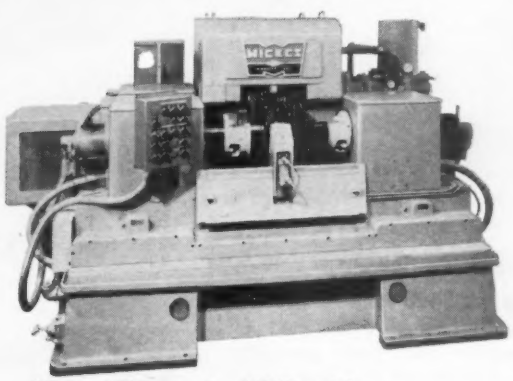
1955 produced a forecast of the future when WICKESmanship developed and introduced the highly adaptable MP-4 Crankpin turning lathe. A true quick-change artist, the MP-4, utilizing a master crankshaft as a template, is designed to turn three different types of crank shafts, turning and cheeking all crank pins at one time. A quick change of the center section on the MP-4 accommodates different spacing of crank pins, as well as different strokes. Master crankshafts can also be changed quickly to handle crankshafts of identical design but with different strokes. Production efficiency proven in steel . . . and on the job . . . since 1955!

The center section . . . heart of the MP-4 . . . can be changed in 4 hours, master crankshafts changed in 2 hours! These are actual changeover times clocked on the job. Your WICKESman is ready to show you how the versatile MP-4 lathe . . . developed by WICKESmanship in 1955 . . . can truly cut your production time and costs in the 60's. Call him today.

WICKES
MACHINE TOOL

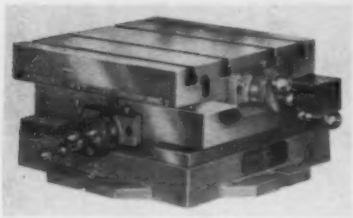
division of the WICKES corporation

615 N. WASHINGTON AVE.
SAGINAW, MICHIGAN
PHONE PLeasant 7-0411



MP-3 . . . MP-8 . . . and . . . MP-10 models are also available in this production-proven series.

"More than a century of machine tool progress".



Cross-Slide Table Designed For X and Y Positioning

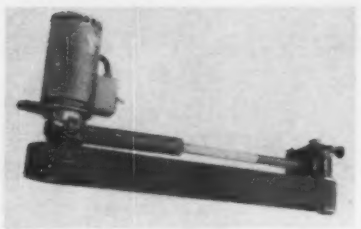
Model CS-12 auxiliary table can be used in conjunction with standard rotary tables, mounting it above or below, to obtain X, Y, and rotary motion.

Unit has 12 x 12-in. working surface, affords 10 in. of travel on each slide, and features hardened and ground Acme feedscrews mounted on tapered roller bearings and running in bronze nuts that are adjustable. Accuracy is within 0.001 in. in the full 10 in. of cross-slide travel .

Additional features include tapered gibs, adjustable quick-set dials graduated in 0.0001 in. increments, stainless steel scales graduated in 0.100-in. increments, and stops on each cross-slide for use with gage blocks or length gages.

Troyke Mfg Co, 11294 Orchard St, Cincinnati 41, Ohii

MORE DATA? Circle 97, inside back cover



Abrasive Belt Grinder Operates at 3400 rpm

The Mighty Mite is designed for mounting on most basic machines, bench mounting, or portable use for deburring, polishing, rough or finish grinding. The 25-lb unit is furnished in 1 and 2 hp, 3 phase continuous duty power. Idler arm rotates 360° allowing unlimited positioning. It uses belts 2½ in. wide up to 60 in. long.

It will mount on almost any improvised bracket and is secured by a ½-in. bolt. On lathes it can be attached to a rectangular bar in the toolpost.

Larmet Co, 108 Wiggs St, PO Box 193 Griffith, Ind

MORE DATA? Circle 98, inside back cover

BURGMASTER USES THESE VICKERS COMPONENTS

▲ **POWER PACKAGES**—A complete Vickers 30-gallon hydraulic power supply was custom-designed and built for this machine. Vickers offers standard and custom power packages to meet every type of application need. Get details from your Vickers application engineer.

◀ **DIRECTIONAL VALVES**—Two types of directional valves—solenoid operated and solenoid controlled, pilot operated—are used on this Burgmaster machine. The complete Vickers line of two- and four-way directional control valves is described in Catalog 5001C.

◀ **MINIATURE DIRECTIONAL CONTROLS**—Series D1L two and four-way valves are designed for low volume systems, are suitable for operation to 1000 psi and have 2 gpm capacity. Low current a-c and d-c solenoids are available in all standard voltages. Write for data sheet D1L-1.

▲ **MOTOR PUMPS**—A 5 HP, double-end motor pump is used on this Burgmaster. The complete Vickers motor pump line offers single, double, two-pressure and two-stage pumps. Use of these motor pumps conserves space and eliminates alignment problems between pump and motor. Details are available in Catalog 5001C.

VICKERS®

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Machinery Hydraulics Division

ADMINISTRATIVE and ENGINEERING CENTER

Department 1410 • Detroit 32, Michigan

CIRCLE 333 READER SERVICE CARD

ANTTI RAIHA, CHIEF ENGINEER, BURGMASTER CORP. SAYS:

"Hydraulic and tape controlled turret drills need sensitive, reliable power systems..."

". . . in order to control tool penetration and table positioning where location tolerances must be held to .001-inch. We've worked with Vickers hydraulic power systems since 1951, beginning with our automatic hydraulic models, we are increasing our activity in this area as the demand for turret drilling machines and tape controlled machines grows.

"In addition to the machine shown, we use Vickers hydraulics on seven different standard models as well as on many specially designed variations of these standard machines. We rely on Vickers hydraulic power systems, not only for their unusually high quality, but because they are easy to maintain and we have the additional assurance of the availability of their worldwide service organization.

"Because Vickers application engineers have given us close cooperation and have a thorough understanding of our requirements, we've been able to develop systems that provide long, trouble-free life."

Whether you are building standard or special purpose machinery, your power and control requirements can be met precisely and economically by the proper application of hydraulic systems. Typical Vickers components and systems used by Burgmaster are shown on the facing page. They are part of the broadest line of top quality hydraulics available anywhere.

VICKERS®

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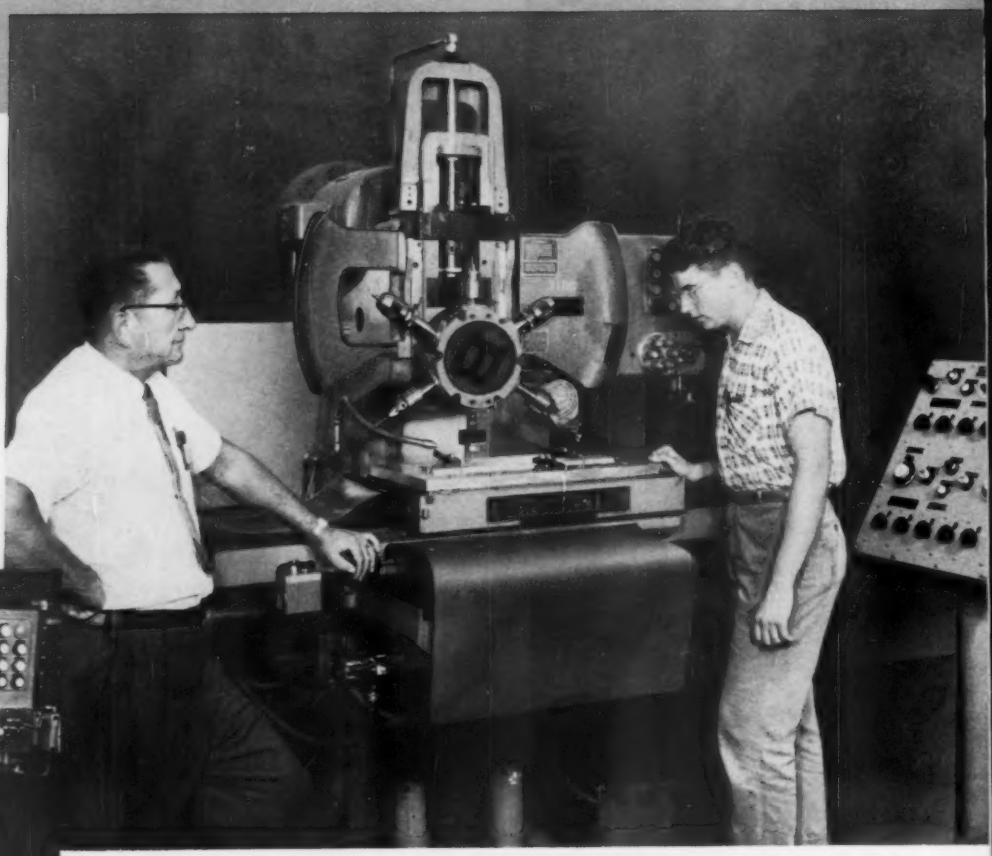
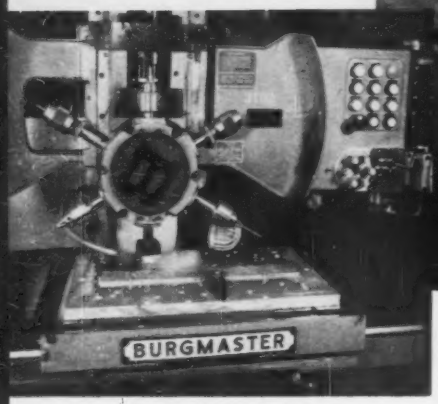
CIRCLE 334 READER SERVICE CARD

Burgmaster....

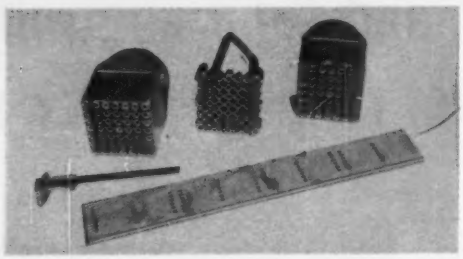
Burgmaster
Model 2BHT
¾" capacity
in steel





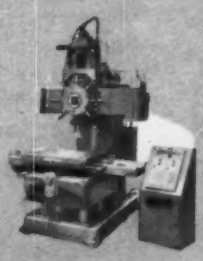
(General Electric Company, Atomic Power Equipment Dept., San Jose, Calif.)

Small lots of 10-25 parts are economically machined. Above fixture cost only $50 — conventional fixture would have cost $500.

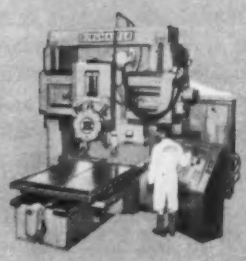


304 Stainless Steel tie plates and a template which is a constantly recurring small lot job.

Model 25AHT
6-spindle, 1¼" capacity in steel. Table travel 15x26, 20x30, 30x45.



Model 3BHT
8-spindle, 1½" capacity in steel. Table travel 20x30, 30x45.



Model 3BHT-B Double Housing Planer Type
8-spindle, 1½" capacity in steel. Table travel 48x60.

CIRCLE 335 READER SERVICE CARD

••• TAPE-CONTROLLED TURRET DRILL

PAYS FOR ITSELF IN LESS THAN 6 MONTHS

World's Largest Builder of Turret Drilling Machines

"0" Manual Power Index ¼" Capacity

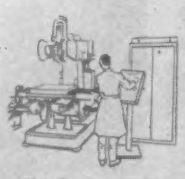
1C Manual Power Index ⅜" Capacity

2B Manual Power Index ⅜" Capacity

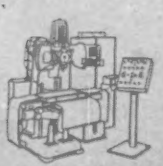
2BR Ram Type Radial Drill ¾" Capacity

2BH Automatic Hydraulic ¾" Capacity

3BH Automatic Hydraulic 1½" Capacity



25AH T Automatic Tape Controlled 1¼" Capacity



2BHT-3BHT Automatic Tape Controlled ¾" and 1½" Capacity

First Job Saves $10,000 Fixture Cost-and $17,000 in Labor...

General Electric's San Jose facility has programmed over 100 different jobs in tape for machining on a Burgmaster Model 2BHT Turret Drill with a General Electric tape control unit. One of these jobs is a Fuel Tie Plate of 304 Stainless Steel. In this operation 73 different holes .254" in diameter and ¾" deep are drilled, bored, reamed and counter-sunk, holding tolerances of +.001, −.000. Time savings per part is 5 hours, plus a saving in drill fixture costs of over $450.00. The Burgmaster Tape-Controlled Model 2BHT runs 16 hours per day regularly, and paid for itself within the first six months of operation.

JOB FACTS

Company: General Electric, Atomic Power Equipment Department, San Jose, California

Machine: Burgmaster Model 2BHT — GENERAL ELECTRIC Mark II Tape-Controlled Turret Drilling, Tapping, and Boring Machine.

Part: Fuel Tie Plate

Lot Size: 10-25

Tolerance: +.001 −.000

Holding: 2 pins on Sub Plate

Machine Operations: Total 291 machine operations — drilling, boring, reaming and counter-sinking

Former Method: 4 Single-Spindle Drills with fixture

Present Method: All operations programmed in tape for Burgmaster Model 2BHT

Savings: 5 hours per part, $450.00 fixture cost per job

Other Advantages: Burgmaster pays for itself in less than six months. Greater accuracy, less cost, no scrap loss. Eliminates operator fatigue. Machines small lots economically.

Send for Literature

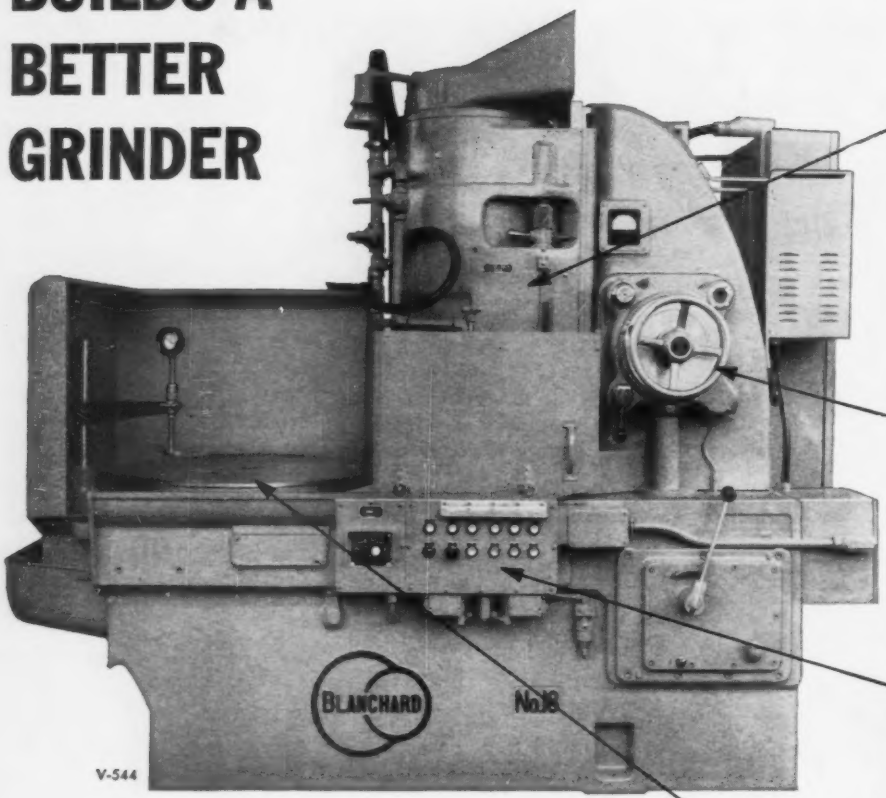
Write for bulletin describing Burgmaster 6- and 8-Spindle Tape-Controlled Turret Drilling, Tapping and Boring Machines. Forty-minute, 16 mm sound film showing all Burgmaster Turret Drills in operation is available without charge from any office

Burgmaster CORPORATION

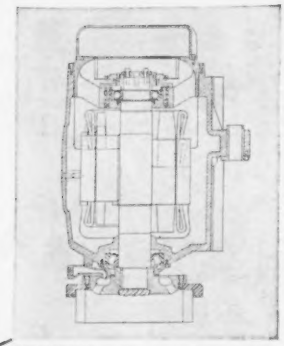
15001 S. Figueroa Street, Gardena, California • FAculty 1-3510, DAvis 9-4158
BURGMASTER DIRECT SALES OFFICES: Midland Park, New Jersey, 196 Greenwood Road, GIlbert 4-3002 • **Melrose Park, Illinois,** 2307 N. Mannheim Road, GLadstone 1-2828 • **Cleveland, Ohio,** ACademy 6-7030 • **Detroit 37, Michigan,** 13730 W. Eight Mile Road, Lincoln 8-4333 • **Northern California, Castro Valley,** 4611 Emily Court, JEfferson 7-1650 • **Kearney & Trecker, C.V.A. Ltd.,** Sole Agents for Great Britain, British Commonwealth and Western Europe • **Mitsubishi Corp.** for Japan, Far East, and South America.

CIRCLE 336 READER SERVICE CARD

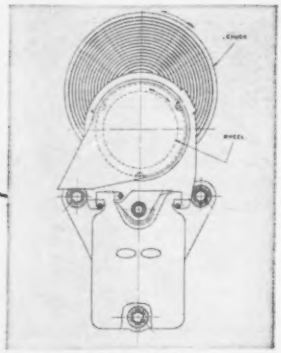
HOW BLANCHARD BUILDS A BETTER GRINDER



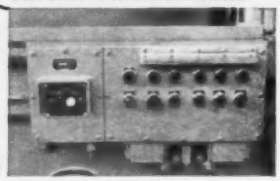
V-544



SPINDLE . . . incorporates a superior, pre-loaded anti-friction bearing system that removes all backlash and radial play. Integral "balanced" mounting of rotor on spindle eliminates vibration.

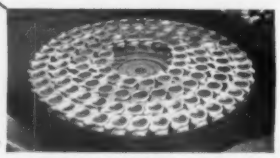


WHEEL HEAD COLUMN . . . is of heavy box-section design for extra rigidity . . . supported at 3 widely-spaced points. Column may be easily adjusted for alignment. Special column tilting devices available to produce concave or convex surfaces.



V-541

GRINDER CONTROL . . . is compact and conveniently located for fatigue-free handling. All control panels are BLANCHARD manufactured for troublefree operation.



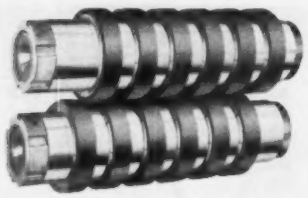
W-949

MAGNETIC CHUCK . . . provides maximum useful magnetic surface . . . has such closely spaced poles, that work as small as a quarter will always touch two or more.

There's no mystery about the *better* performance you get with a BLANCHARD Surface Grinder. It's simply a matter of *better* design of each individual machine part. For example, look at just 4 features of the No. 18, shown at the right.

Get complete details on all 24 models of BLANCHARD grinders. They're today's leading high precision, high production grinders on materials ranging from carbon to quartz . . . from bronze to steel. You can handle parts ranging from tiny jewels to giant plates up to 108″ across corners.

PUT IT ON THE BLANCHARD **THE BLANCHARD MACHINE COMPANY**
64 State Street, Cambridge 39, Massachusetts



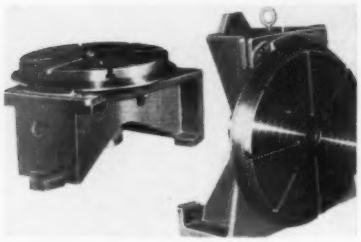
Matched Carbide Rimmed Knives Up Gang Slitting Output

Gang slitting of light gage materials with matched carbide rimmed rotary knives provides a number of advantages. Knives, with tungsten carbide outer rims and alloy steel bodies, are reported to hold their cutting edges 10 to 15 times longer between re-grindings than conventional high alloy slitting knives. Greatly lengthened service life permits slitting machines to remain in continuous operation for long periods of time without shutdown for knife re-grinding.

Knives can be furnished in a wide range of sizes with arbors and spacers for any gang slitting requirement.

Cowles Tool Co, 2086 W 110th St, Cleveland 2, Ohio

MORE DATA? Circle 99, inside back cover



Rotary Table And Angle Plate Gives Readings to 5 Minutes

Combination rotary table and angle plate that can be used horizontially or vertically for inspection, layout, or machining has a free wheeling face plate that rotates 360 degree with a radial accuracy to 5 minutes visual reading.

Graduations are on a 45 degree angle for convenient reading in either horizontal or vertical position. The 18-in. diameter table has positioning rings and 8 T-slots for loading and clamping parts and is said to have flatness and runout held to 0.0002 in.

A centering plug and sine bar arrangement for Jo block is offered as an optional extra.

Machine Products Corp, 6771 E McNichols Rd, Detroit, 12, Mich

MORE DATA? Circle 100 inside back cover

NOW INTRODUCING THE . . .

JARVIS

Dril-King

No. 65 for Drilling • No. 66 for Drilling & Tapping

LOWEST PRICED AMERICAN MADE UNIVERSAL DRILLING & TAPPING MACHINE

Basic Drilling Machine Price Starts at Only $1195.00 (Less Spindle Assemblies)

Floor Type, Self-Contained Universal Joint Drilling & Tapping Machine.

Designed for Small Parts Production Where Small Hole Drilling and Tapping is Required.

12 Spindle Drivers, 4 Speed Selections. T Track Vertical Feed Work Table.

Capable of Standard Center Distances down to .390, closer upon specific application.

- Head remains stationary while counter balanced table feeds work pieces up to drills or taps.
- Rapid changeover from one job to another. Well suited for either short or long runs.
- Work table features 2 "T" tracks, has adjustable depth stops. Depth controlled either mechanically or electrically.
- Standard spindle assemblies can be arranged in jig bored cluster plates to your prints, or used with adjustable arms. Over 35 standard spindle assemblies available to fit any job.

Overall Height 66"
Height from floor to Work Table 39"

WRITE, PHONE OR SEND COUPON FOR FACTS AND FIGURES

Jarvis CORPORATION
Telephone Diamond 7-3321
Precision Pioneers For Years

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26 Pease Ave., Middletown, Conn.

☐ Have Representative call
☐ Send "Dril-King" Brochure

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Company _____
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MANUFACTURI MEN AND YOU'LL FIND THIS

IS METALWORKIN MOST POWERF SELLING TOOL

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UL

If you sell to metalworking, ask your customers to tell you which business publications they find most useful in their work—then advertise there. Twenty-five companies conducted such surveys on their own during the last 10 years—and American Machinist/Metalworking Manufacturing was consistently the winner . . . hands down!

Reason? AM/MM is the technical publication of metalworking—and metalworking is a highly technical industry.

AM/MM concentrates on how-to articles, case histories and *working* information on the often highly complex methods and procedures involved in manufacturing things from metal more efficiently, more profitably. In short, it's a 26-times-a-year work book. If metalworking is your market, it will work for you.

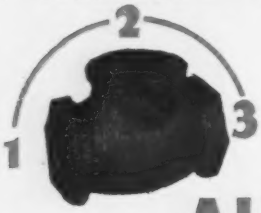
For up-to-date facts and figures on metalworking, ask your AM/MM *district manager for a copy of the Market Guide for Sales Executives.*

In metalworking—men who matter read...

American Machinist / ***Metalworking Manufacturing***

A McGraw-Hill Publication, 330 West 42nd Street, New York 36, N. Y.

What is done
is DONE...
on the GOSS & DeLEEUW



AUTOMATIC
CHUCKING
MACHINE

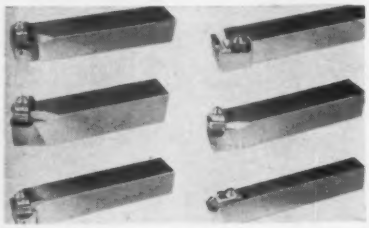
There are no half-finished pieces lying around at the end of the day when you put your work on this outstanding machine.

The "1-2-3" feature—available only on the Goss & De Leeuw Automatic Chucker —provides the means of finish machining three ends of a part without changing set-up.

Note some of the typical parts machined. Ask for illustrated literature giving further details and send samples of your work for a cost estimate on handling it on the Goss & De Leeuw.

GOSS & DeLEEUW
QUALITY · PRODUCT · QUANTITY

GOSS and DE LEEUW
MACHINE COMPANY, KENSINGTON, CONN., U.S.A.



Hi-Shear Turning Tools Feature Positive Rake Angles Up to 13°

Hi-Shear turning tools with carbide throw-away inserts are reported to provide better cutting action on aluminum, titanium, stainless, and a variety of refractory metals. Positive rake angles decrease chip friction and both chipbreaker and inserts are lapped to prevent chip welding. Greater efficiency is said to result when cutting work—hardening materials and removing tough outer skins, and cleaner cuts are provided on relatively soft or tough and gummy materials.

These tools are available in six standard holder styles and 29 sizes, both right and left hand cutting.

Valenite Metals, Box 205, Royal Oak, Mich

MORE DATA? Circle 101, inside back cover

Cabinet Allows Automatic Wet Blasting of Parts in Fixtures

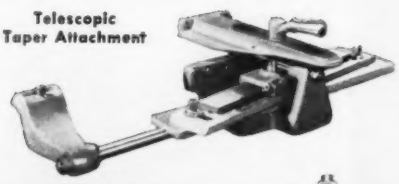
Fully automated wet blast cabinet allows an operator to load small parts into fixtures on a rotating table for complete wet blast finishing.

The 50 by 75-in. cabinet consists of a load and unload section, a blast section which can be fitted with up to 6 40-cfm guns, fixed or oscillating, a rinse section, and drying section. If required, a rustproofing section can be added. Design of the rotary table allows either indexing or constant motion operation.

Pressure Blast Mfg Co, Inc, 27 Pleasant St, Manchester, Conn

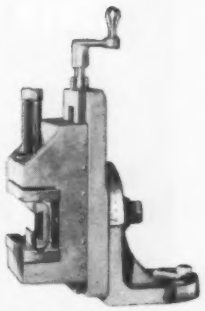
MORE DATA? Circle 102, inside back cover

Telescopic Taper Attachment



Ball Bearing Live Centers

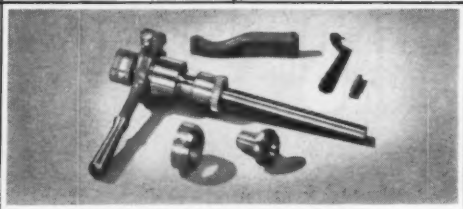
Follower Rest



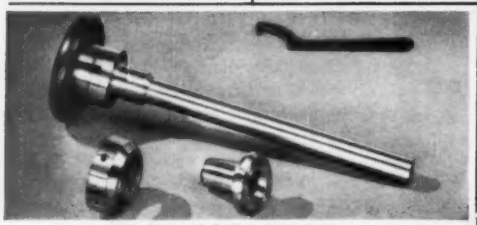
Milling Attachment

External Grinder

Steady Rest

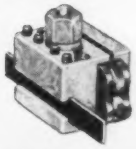


Handlever Collet Attachment

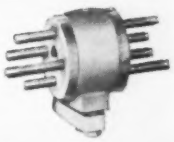


Handwheel Collet Attachment

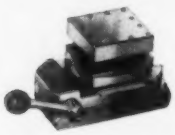
Collets



10-IN-1 Tool Holder

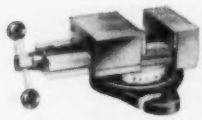


4-Position Carriage Stop

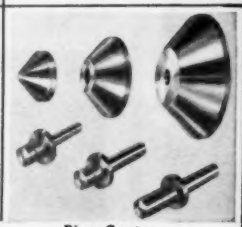


Square Turret Tool Block

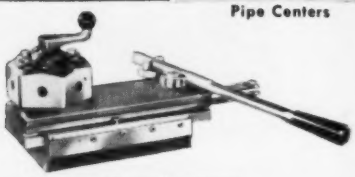
Cutter Bit Grinding Block



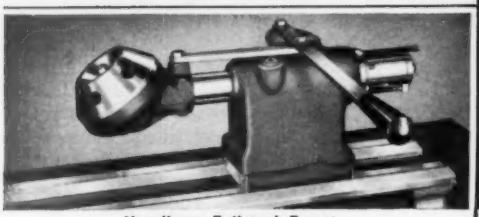
Swivel Machine Vise



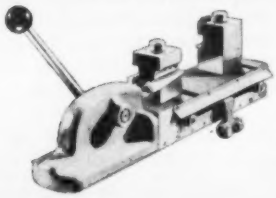
Pipe Centers



Handlever Bed Turret



Handlever Tailstock Turret



Handlever Double Tool Cross Slide

SOUTH BEND

ATTACHMENTS

help you get more work out of your machines

- CUT MACHINING TIME
- SIMPLIFY DIFFICULT JOBS
- SPEED UP TOOLING
- HANDLE MORE TYPES OF JOBS

SOUTH BEND LATHE, INC., South Bend 22, Ind.
Builders of Lathes, Milling Machines, Shapers, Drill Presses and Pedestal Grinders

SOUTH BEND

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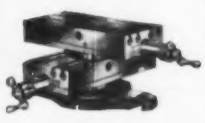
We would like to know more about all 212 South Bend Machine Tool Attachments.

Name_____ Title_____

Company_____

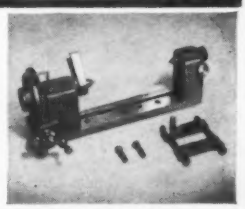
Street_____

City_____ Zone_____ State_____



Universal Table

Rotary Indexing Table



Indexing Centers

ESSENTIAL TO NUMERICAL CONTROL

Maxitorq

ELECTRIC

CLUTCHES and BRAKES

COMPACT DESIGN • FAST RESPONSE
POSITIVE REMOTE CONTROL PERFORMANCE

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments. Can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V d.c. Other voltages on special order.

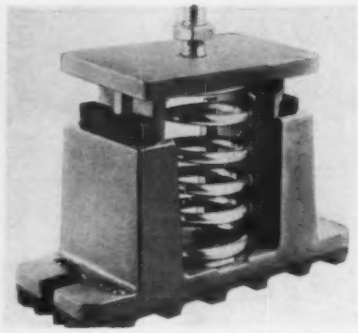
FAST ACTING
POSITIVE ENGAGEMENT and RELEASE
REMOTE CONTROL
COMPACT DESIGN
SELF ADJUSTING
NO TROUBLESOME WIRING

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us. Phone, wire or write Dept—M for Bulletin No. 90.

THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

2CJ61

NEW SHOP EQUIPMENT



Spring Mountings for Machinery Cut Installation Time

Type LNAA mounting, an isolator utilizing a single helical coil steel spring as the cushioning medium, is available in load-carrying capacities from 50 to 540 lb. Wide range is provided by a selection of four different springs which can be inserted into the isolator housing.

The cast semi-steel housing, which measures 3¾ x 3¼ x 5⅛ in. has an access port on each side to allow for insertion of a stiffer spring in case accessories are added to the machine.

Korfund Co, Shock & Vibration Div, 39B Cantaigue Rd, Westbury, LI, NY

MORE DATA? Circle 103, inside back cover

160-amp Heliweld Holder Has Built-In Thumb-Operated Gas Valve

The H16-B air-cooled holder incorporates a slide-type poppet valve on the handle. To open the gas valve, a serrated sliding sleeve is drawn to the rear where it holds in the open position; sleeve is moved forward to close. The 2⅞ in. head clearance permits its use in confined spaces. A variety of nozzle orifice sizes are available in 1¼ and 1⅝-in. lengths.

Tungsten electrodes from 0.20 through 5/32-in. diameters and from 2 to 7 in. in length can be handled. Argon, helium, or mixtures of argon and helium shielding gases can be used.

Air Reduction Sales Co, 150 E 42nd St, New York 17, NY

MORE DATA? Circle 104, inside back cover

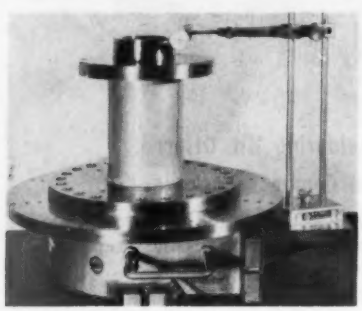
Fill and Wipe Machine Employs Up to Five Heads

Machine for the automatic finishing of dials, emblems, and various piece parts is designed for applications where the first or second surface depressions are to be filled and then wiped and polished.

Rotary index table has eight spindles which spin in five stations and are available for loading and unloading in three stations. This table can be equipped to take any combination (up to five) of interchangeable accessory heads including a fill head, a smear wipe, a light bug, and a painting head.

Conforming Matrix Corp, 758 New York Ave, Toledo 11, Ohio

MORE DATA? Circle 105, inside back cover



24-in. Roto Grind Is Accurate in Millionths

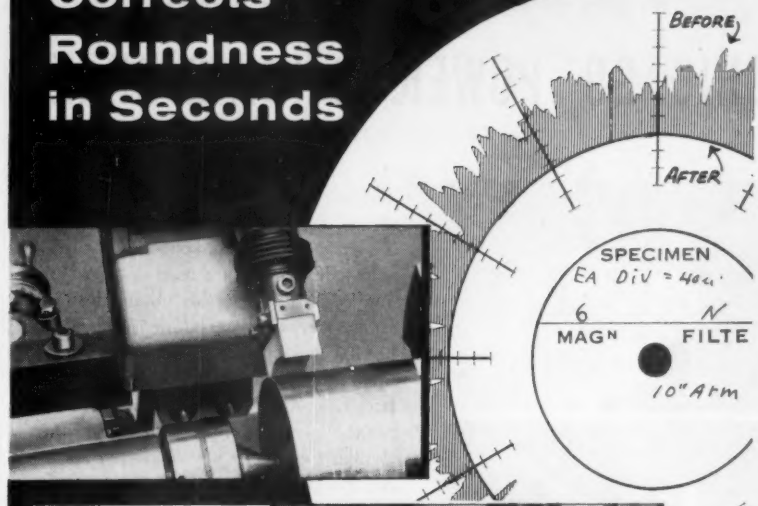
Model 724-B can be air or electrically operated. Variable speed motor allows checking of concentricity and flatness as well as grinding of parts to less than 50 millionths. This power feature allows checking with both hands free.

Unit can be used on a jig grinder to grind extremely close tolerances. With the grinding attachment, the mill can also be altered for OD or ID grinding. The model can be purchased in 24 indexes for indexing 2, 4, 6, 8, 12, 24, and 48 indexes.

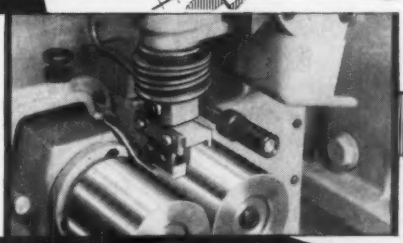
M & M Tool & Mfg Co, 1124 E Third St, Dayton 2, Ohio

MORE DATA? Circle 106, inside back cover

MICROSTONING
Corrects Roundness in Seconds



This chart demonstrates the remarkable results from Taft-Peirce Microstoning. Outside trace shows an average roundness of .00028" as ground, inside trace shows roundness improved to an average of .000030", after microstoning! These Taft-Peirce Microstoning heads show where the patented Supfina pneumatic oscillation takes place, driving an abrasive stone at frequency of 1800 to 2000 cycles per minute against a rotating workpiece — achieving desired finish and geometric correction in one operation!



Anyone can get roundness correction if he doesn't care about time and cost. But, Taft-Peirce Microstoning produces a *controlled* microinch surface finish, removes cutting tool marks, and dramatically improves roundness — all in one simple operation and in a matter of seconds!

You'll find the results in product quality and performance amazing. Shafts and cylinders run quieter, work smoother, won't wear as fast. And you'll find your whole finishing operation is faster, costs less and is easier to operate. All types of metals, hard plastics, and other non-metallic materials can be microstoned.

Try Microstoning on your products! You can use Taft-Peirce/Supfina Microstoners on lathes, boring mills, planers and other machines; or select Centerless Plunge-Cut and Through-Feed Centerless Machines for volume production on small parts. See your nearest Taft-Peirce Agent or send for new Microstoning Catalog No. 319 for detailed information.

Finish it with

TAFT-PEIRCE *SUPFINA*

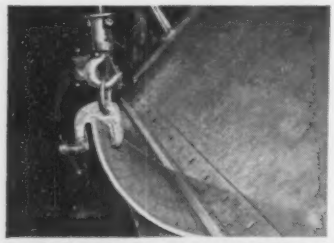
TAFT-PEIRCE MANUFACTURING CO. 13 MECHANIC AVENUE, WOONSOCKET, R. I.

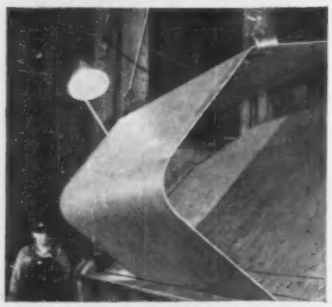
Bending Steel Plates for WELDMENTS?

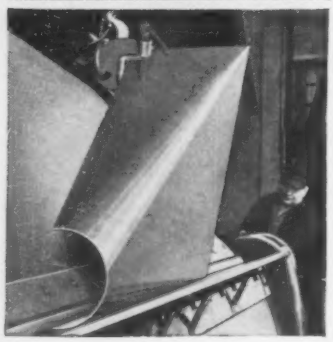
do it economically with

CHICAGO® POWER BENDING BRAKE

(no dies needed)





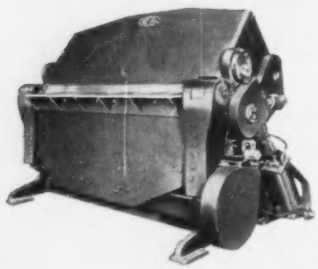


The accompanying illustrations give an idea of the versatility of the CHICAGO bending brake. No dies have to be changed or adjusted—no dies are used on these jobs. Yet, duplication is easily obtained on successive pieces. The machine is quickly adjustable for different thicknesses of material up to rated capacity. Automatic stop regulates the angle of bend. This, too, is adjustable to any degree of bend. The ease of changing from one job to another and the elimination of die costs make the CHICAGO bending brake the economical method for bending steel plates for weldments.

Many standard sizes are available with capacities for bending mild steel up to 12 feet by ¾ inch or 16 feet by ½ inch. Also many standard sizes in hand and power operated models for sheet metal.

BULLETIN P-55
This bulletin gives the details of how these and many other jobs are handled. Also complete description of the machine and specifications of the standard sizes.
Ask for a copy.

Front view of one of the heavy duty models of CHICAGO power bending brake showing the operation end of the machine.



Recommendations for any job on request.

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Press Brakes • Straight-Side Presses • Press Brake Dies

Hand and Power Brakes • Special Metal-Forming Machines

DREIS & KRUMP MANUFACTURING CO.

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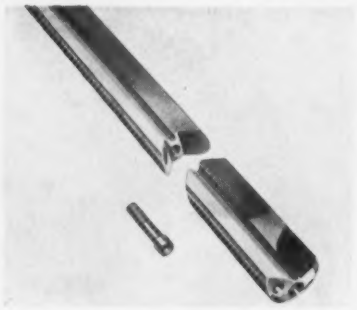
NEW SHOP EQUIPMENT

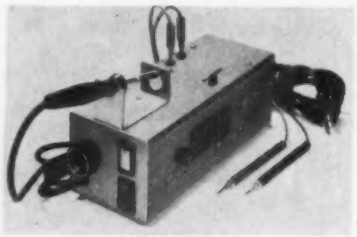


Gun Drills Equipped With Detachable Heads

Quick-change detachable heads permit easy replacement and resharpening without removing the shank from the machine. Heads are securely joined to the shank in a V-type assembly by means of a socket head cap screw. Gun drills with these heads are available in center-cut as well as target-type design.

National Twist Drill & Tool Co, Rochester, Mich

MORE DATA? Circle 107, inside back cover



Soldering Kit Offered In Compact Package

Models SK-1 and SK-2 for laboratory, production line, repair and service work, combine soldering equipment, continuity checker, and outlet box in one small housing. A 25-w pencil-type iron for intricate soldering is equipped with a variable heat control. Model SK-1 is equipped with GE 6-v iron; Model SK-2 employs a Hexacon 110-v iron. Both kits include two fine tips, conical and chisel type. Built-in buzzer with test leads is designed for tracing and troubleshooting circuits. Two grounding-type outlets are incorporated to plug in and control accessory equipment and lights used on the bench. Each kit is furnished with a 10-ft 3-conductor line cord. Also included is built-in fused protection for 15 amps 115 v; and a power switch controlling the unit.

C B C Electronics Co, 2601 N Howard St, Philadelphia 33, Pa

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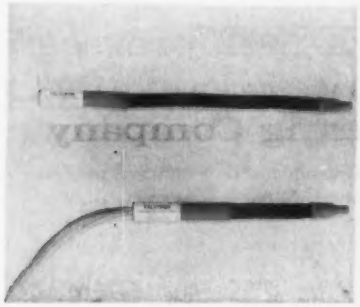

Flexible TIG Torch Available In Extra Long Model

Controlled angle torch with a 9-in. flexible body of molded neoprene is three times longer than the standard 3-in. unit. Easy adjustment changes the angle at will and permits extension of the tip into hidden recesses, or even to double back 180° into an impossible-to-reach corner.

Falstrom Co, 222 Falstrom Ct, Passaic, NJ

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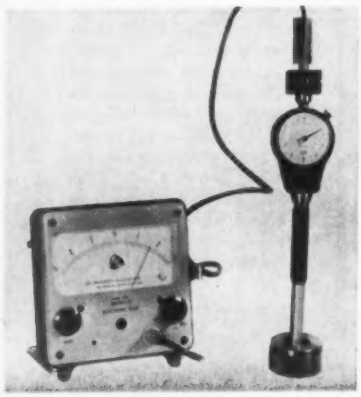

Combination Gage Introduced by Boice

This precision measuring instrument is designed for applications where large amounts of stock must be removed yet dimensions must be checked periodically with a degree of accuracy usually associated with final finish.

The device is a combination of a mechanical dial indicating gage which provides ample range for deep cuts, and an electronic indicator which automatically becomes activated to check with extreme accuracy as finish size is approached. Electronic indicator is battery operated and the gage is portable. Model pictured will gage bores from ¼ in. ID and up.

Boice Gages Inc, Hyde Park, NY

MORE DATA? Circle 110, inside back cover

There's a BIG difference in floor absorbents

MAKE THIS DISCOVERY!

RIGHT IN YOUR OWN OFFICE you can test the difference of Eagle-Picher Industrial Floor-Dry with whatever oil absorbent you're now using. You'll discover it actually absorbs as much as 100% or more liquid per pound than other floor drying materials.

YOU'LL ALSO PROVE that Eagle-Picher Floor-Dry retains its skid-proof granular mineral form even when saturated. It doesn't mud or pack. Light in weight, it spreads easier and covers a larger area. Non-combustible, it has no chemical reaction. And possessing unusual reflective power, Floor-Dry makes working conditions bright and pleasant, as well as safe!

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WRITE TODAY. Our Eagle-Picher representative will bring the portable laboratory to your office where you may make this test yourself. The Eagle-Picher Company, Dept. AM-1016, Cincinnati 1, Ohio.

COOK OUTS and two Verson presses help balance production at Structo Manufacturing Company

Seasonal production problems can be tough and costly. Structo Manufacturing Company, Freeport, Illinois, solved such a problem. As the world's largest manufacturer of heavy gauge steel toys, Structo balanced its production of toys for the Christmas market with the production of barbecue grills for the summer market. Two 350 ton Verson crank presses are the key units in the grill production set up. If you have production balancing problems, talk to your Verson Representative. He will be glad to show you how Verson equipment can help you in balancing production.

Originators and pioneers of allsteel stamping press construction

VERSON ALLSTEEL PRESS CO.

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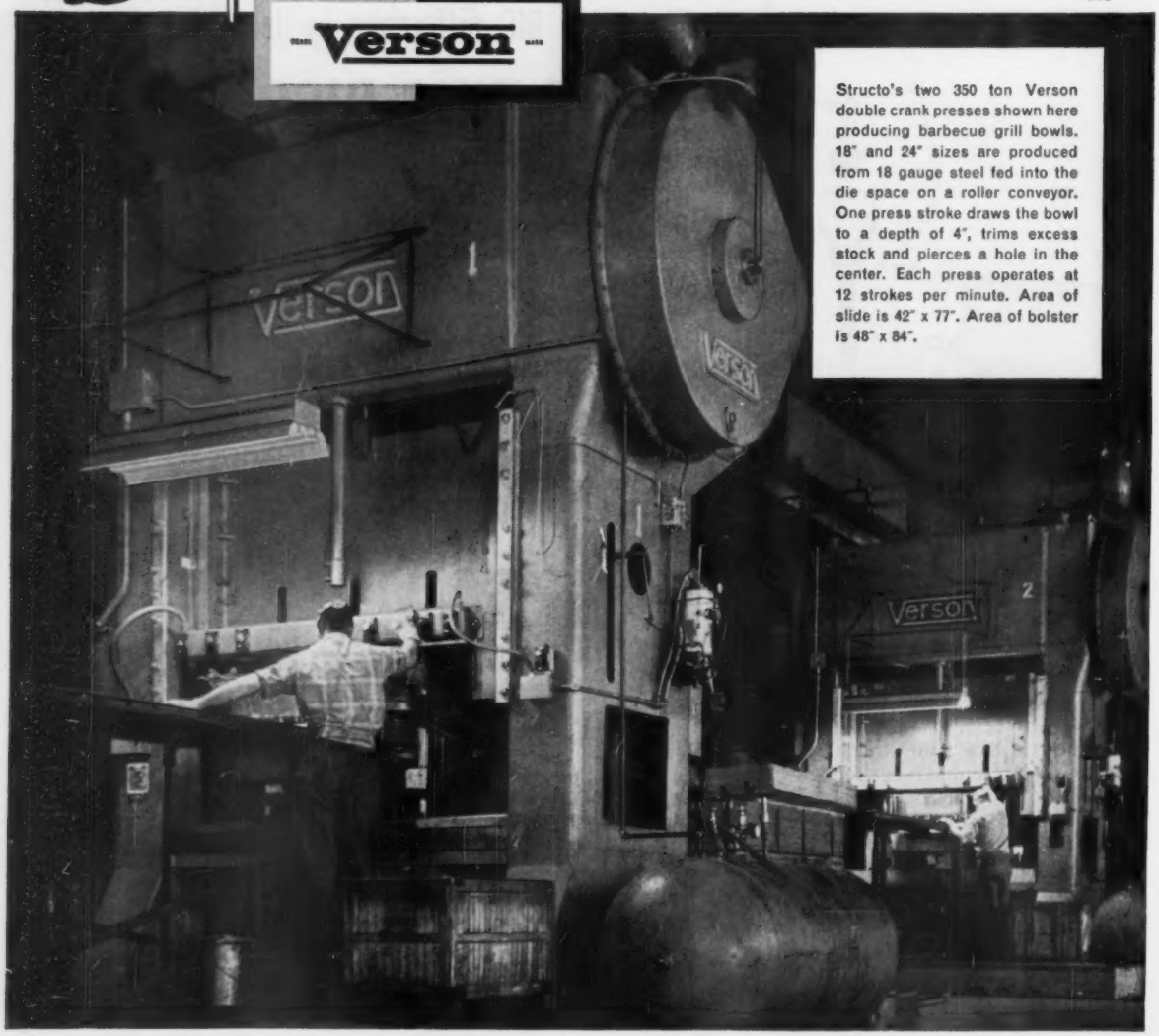
MANUFACTURERS OF MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES
TRANSMAT PRESSES IMPACT MACHINING PRESSES TOOLING DIE CUSHIONS
VERSON-WHEELON HYDRAULIC PRESSES HYDRAULIC SHEARS PLASTIC MOLDING PRESSES

268



Structo's two 350 ton Verson double crank presses shown here producing barbecue grill bowls. 18" and 24" sizes are produced from 18 gauge steel fed into the die space on a roller conveyor. One press stroke draws the bowl to a depth of 4", trims excess stock and pierces a hole in the center. Each press operates at 12 strokes per minute. Area of slide is 42" x 77". Area of bolster is 48" x 84".

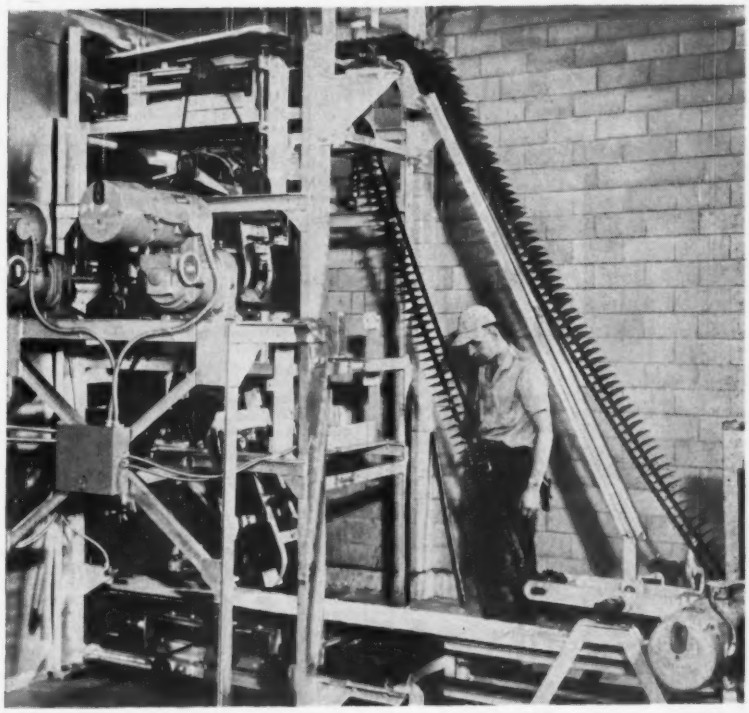
New Equipment at A O Smith Doubles Electrode Production

Doubling production and, at the same time, expanding the product line to cover some 500 different types of welding electrodes has been achieved at A O Smith's Leola, Pa, plant. Major factors in the increase have been the installation of a wire draw bench that operates at over 1200 fpm, and a new, continuous, gas-fired baking oven, 150 ft long, that operates at temperatures as high as 1000 F and will bake 12,000 lb an hour.

The draw bench features rotating draw dies which serve to equalize wear in the bore of the die and insure roundness of the wire throughout the life of the die, and an unusual flying shear consisting of two opposed wheels, each carrying two carbide cutting blades.

Hot drawn wire is delivered in 600 to 1200-lb coils, mechanically descaled, then cold drawn in two or three passes to the required diameter. ⅛-in. wire is drawn from 7/32-in. stock in three passes, other sizes up to 5/16-in. are drawn in two passes. After drawing, the wire passes through a special straightening frame of 28 horizontal and vertical rolls before passing to the cutoff wheels and being ejected into tote boxes.

Wires are fed automatically through the coating machine, then one end is automatically brushed to remove the coating for about an inch, while the other end is brushed to bare the end for striking the arc. Electrodes then pass into the low temperature bake oven, 200 to 500 F from where they may be delivered directly to a cooling conveyor that forms part of the high-temperature oven. If a higher temperature bake is required, up to 1000 F, a pivoting flight conveyor can be swung down to pick up the electrodes as they emerge from the first oven and deliver them to the top of the high-temperature oven. After making four passes through this oven they are delivered to the cooling conveyor and pass on to inspection and packaging.



Swinging flight conveyor can be raised to permit electrodes to pass into cooling tunnel or lowered to carry them through high temperature bake before cooling

Chemical Milling for Boeing

Boeing Co's Transport Division, Seattle, has awarded a $600,000 contract to the Chemical Contour Corp of Gardena, Calif, for the chemical milling of structural parts for Boeing's new 737 jet airliner. Under this first production increment contract, the company will perform chemical milling on wing components for the jet. Components to be milled range in lengths up to 55 ft and will be tapered over the entire length.

The 55-ft-long parts are believed to be the longest units ever processed by chemical milling and mark its first major application in the production of Boeing's commercial aircraft.

Aerospace, Auto Divisions Set Up by Bendix Corp

Manufacturing and engineering operations of Bendix Corp in South Bend, Ind, (company's largest plant) have been reorganized as two separate divisions of the organization. The two new operating units will be called the Bendix Products Aerospace division and the Bendix Products Automotive division. Realignment separates the military and commercial operations of the company at South Bend.

Bliss Consolidates Operations

The Salem and Canton, Ohio, operations of E W Bliss Co have been consolidated into a single heavy equipment division. George Perrault Jr, vice president and manager of the Salem division, will manage the new operation with headquarters in Salem. The two plants of the new division are only 30 miles apart and their facilities are complementary. Combining of the two units into a single operating facility with approximately a million square feet of floor space will enable the company to expand its activities in the custom-built machinery field. Production of the new division will include the firm's complete line of rolling mill equipment, heavy mechanical and hydraulic presses, large custom machinery, and special contract items. The move provides a more versatile contract manufacturing capability than has previously been available.

While no immediate effect on employment levels at either plant is expected immediately, Bliss feels that additional business will develop to increase employment at both. •

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to this one!

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MACHINES AND ATTACHMENTS

1 LATHE—*Nebel Machine Tool Corp, Dept 10, 103 S Cooper Ave, Cincinnati 15, Ohio.* 20-page illustrated bulletin 222 describes the new, improved Micro-Turn high-speed precision unit. Gives details on the Micro-Turn's mechanical speed variator and coaxial spindle design providing infinite spindle speed selection, constant horsepower, and high torque. Engineering details and specifications included.

2 HYDRAULIC SHEARS—*Verson All-steel Press Co, 9300 S Kenwood Ave, Chicago 19, Ill.* 4-page bulletin VHS-61 gives design details and specifications for completely redesigned line of hydraulic shears. Accompanying slide calculator simplifies computation of the tonnage required to shear all commonly used metals. It may also be used to determine quickly whether an available shear has sufficient capacity for a given job, or what maximum thickness of any type of plate can be sheared in an available shear.

3 MULTIPLE-SPINDLE DRILL HEADS—*Zagar Inc, 24000 Lakeland Blvd, Cleveland 23, Ohio.* 16-page illustrated brochure covers gearless crank drive heads for drilling, reaming, tapping, and boring. Suggests product application; explains relation of heads to automation, and includes all drawings and tables required in basic production planning. All basic head shapes and sizes are pictured and all dimensions for heads and spindles are charted with accompanying keyed line drawings.

● DIE TRYOUT PRESSES — *Alpha Press & Machine Inc, 9231 Freeland, Detroit, Mich.* 16-page catalog pictures and describes complete line of standard rotary head units. Explains advantages of design which makes both die members accessible for finishing operations without disturbing tryout press setup. Dimensions, specifications, and drawings of the 50 to 300-ton capacity presses are given, including portable models. Request direct on company letterhead.

4 BORING AND FACING HEADS—*Giddings & Lewis Machine Tool Co, Fond du Lac, Wis.* 12-page catalog D-550 gives details on complete line of CF continuous-feed heads for boring, facing, turning, backfacing, recessing, threading, grooving, grinding and other work. Line includes 12 standard models covering a range of work from 7/16 in. (with pencil boring tools) through 96 in. in diameter. All models provide continuous, uninterrupted radial tool feed for true phonograph machining over the full work range of each head. Optional equipment and accessories available are described in detail.

5 PRECISION HOLE BORER—*Canton Tool Manufacturing Co, East Canton, Ohio.* Brochure describes this unit, a machine tool combining the capabilities of an ultra-precision boring mechanism with a simple positioning method. Illustrated job applications show economies in manufacturing time, labor cost, and fixturing.

TOOLS AND ACCESSORIES

6 AUTOMATIC CONTROLS FOR ANOCUTTING — *Anocut Engineering Co, 631 Washington Blvd, Chicago 6, Ill.* 8-page illustrated booklet B-1 explains how proper automatic current controls affect the electrolytic machining technique, Anocutting. Tells what these automatic controls do, and how they help the average operator to achieve consistently expert results. The central control unit, an electronic voltage computer, is shown and its

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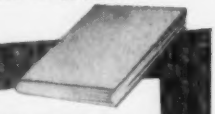

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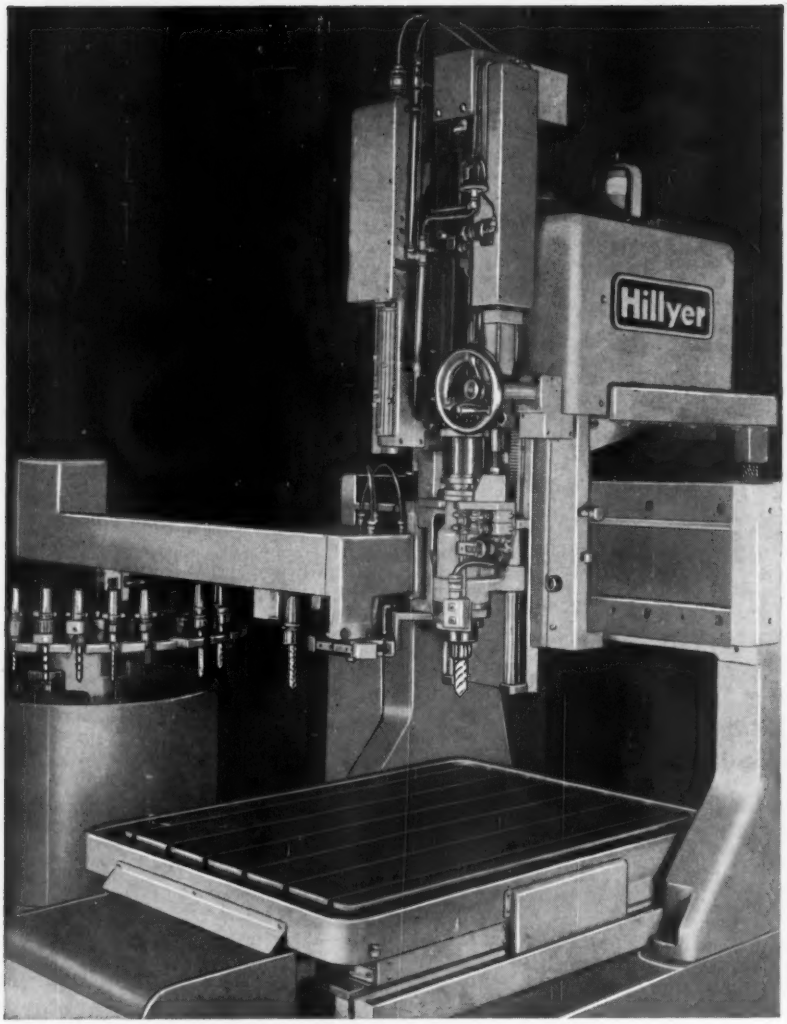

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HILLYER'S NEW TAPE CONTROLLED DRILLING MACHINE WITH

AUTOMATIC TOOL CHANGER is **substantially less than its closest competition** — with features superior to them all! In addition to complete numerical control of all drilling, reaming, tapping and straight-line milling operations, the Model TC-36C automatically changes tools as designated by dial or tape. Any combination of spindle speed, feed rates, or depths can be selected at any time by dial or tape command. Any combination of these three variables can be selected at any time. And the machine permits a given tool to be programmed to varying levels and varying depths, all on the same work piece, all within a working range of 36" x 24". A total of 30 tools can be accommodated in the changer at any one time **— yet tool changing takes just seconds!**

Write today for complete details to Dept. 321.

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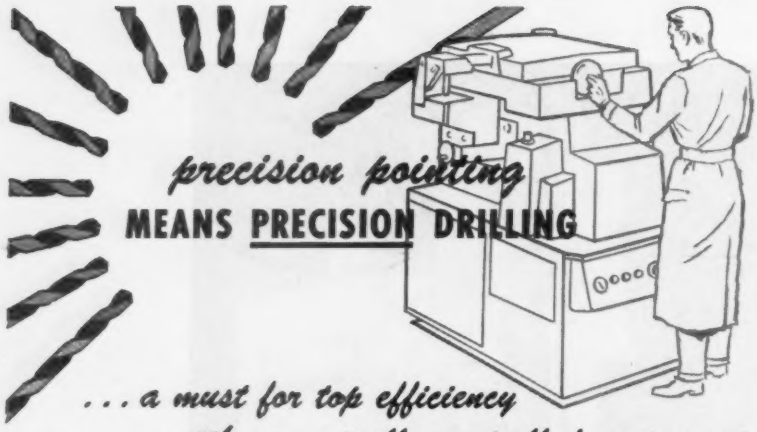

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MEANS PRECISION DRILLING
. . . a must for top efficiency with numerically controlled equipment

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WINSLO-MATIC DRILL POINTER

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Drills sharpened on the WINSLO-MATIC Drill Pointer are concentric within .0002". They produce up to twice as many precision holes within .001 of drill size (even in the new super metals). This precision pointing provides other benefits too. Faster drilling. Fewer rejects. Elimination of most reaming requirements.

The WINSLO-MATIC Drill Pointer handles drills from 1/32" to 1½" diameters. Produces conventional chisel-type points as well as helical (self-centering) points for optimum performance on tape controlled drilling machines. Also sharpens taps, center drills and core drills.

Whether you use conventional manufacturing methods or numerically controlled machines . . . it's good business to make the WINSLO-MATIC Drill Pointer a part of your operations.

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CIRCLE 349 READER SERVICE CARD

Two Hardness Testers in a Single Instrument

The new Wilson Rockwell TwinTester combines in one instrument the functions of both a Rockwell and a Rockwell superficial hardness tester. Designed primarily for use in such areas as tool departments, maintenance repair shops and laboratories, the TwinTester offers many outstanding features.

Large direct-reading dial is marked with B and C scales for Rockwell hardness, and N and T scales for superficial Rockwell hardness readings. Just one zero set position for all scales.

Easy to operate, the TwinTester can be changed from Rockwell to Rockwell superficial testing in seconds.

Complete equipment includes cowl, ball penetrator for B and T scales, Rockwell test blocks, anvils, dust cover and protective sleeve set.

A complete line of Wilson Rockwell instruments is available, including semi and fully automatic models. Wilson "Brale" Diamond Penetrators assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the TwinTester as well as on the full line of Wilson Rockwell hardness testers.

Wilson "Rockwell" TwinTester

WILSON "ROCKWELL" HARDNESS TESTERS

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
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operation explained. Describes complete line of power supply units ranging in capacity from 50 to 10,000 amp of machining current.

7 DAVIS TOOLING AND SETUP ACCESSORIES — *Davis Division, Giddings & Lewis Machine Tool Co, Fond du Lac, Wis.* 16-page catalog D-540 illustrates and describes complete line. Products include standard and special arbors and sleeves for use with shank-mounted tools; adjustable drawkeys; box-type angle plates; open-side V blocks; stud and T-nut sets; adjustable stop jacks, cross slot stop blocks, and combination stop and jack blocks; and setup accessories for vertical turret lathes and vertical boring mills.

8 RUBY GRINDING WHEELS — *Simonds Abrasive Co, Tacony & Fraley Sts, Philadelphia 37, Pa.* 4-page illustrated bulletin, Form ESA-323, describes RA Borolon V8 vitrified bonded grinding wheels containing man-made rubies as the abrasive. Ruby red in color, they are claimed to be distinctively different in performance over other wheels, especially for precision grinding operations on the hardest, toughest alloy steels, including space age metals. Includes grain and grade recommendations, grinding suggestions, and supporting performance data.

9 ELECTRON MICROSCOPE—*Philips Electronic Instruments, 750 S Fulton Ave, Mount Vernon, NY.* 6-page folder EM-200 covers features of the Norelco EM-200 with resolving power of 10A and better. Magnification range is 1500-200,000 X on photographic plates, 700-90,000 X on 35mm film. Discusses micrographic facilities, focusing astigmatism compensation, electron diffraction, specimen chamber cooling, specimen holder, aperturing, and electron optical system.

10 CAM - OPERATED INDEXING UNITS—*Standard Tool & Manufacturing Co, 733 Schuyler Ave, Lyndhurst, NJ.* 16-page engineering specification bulletin 26 covers Model ST-A9AB indexing units. Contains complete information on the two models, the basic unit and the precision unit. Gives details on available indexing cams and dial plates, on machine bases, motors, and electric timers. Load rating table and load calculation methods are included as well as a nomogram for weight and moment of inertia calculations and a torque rating table.

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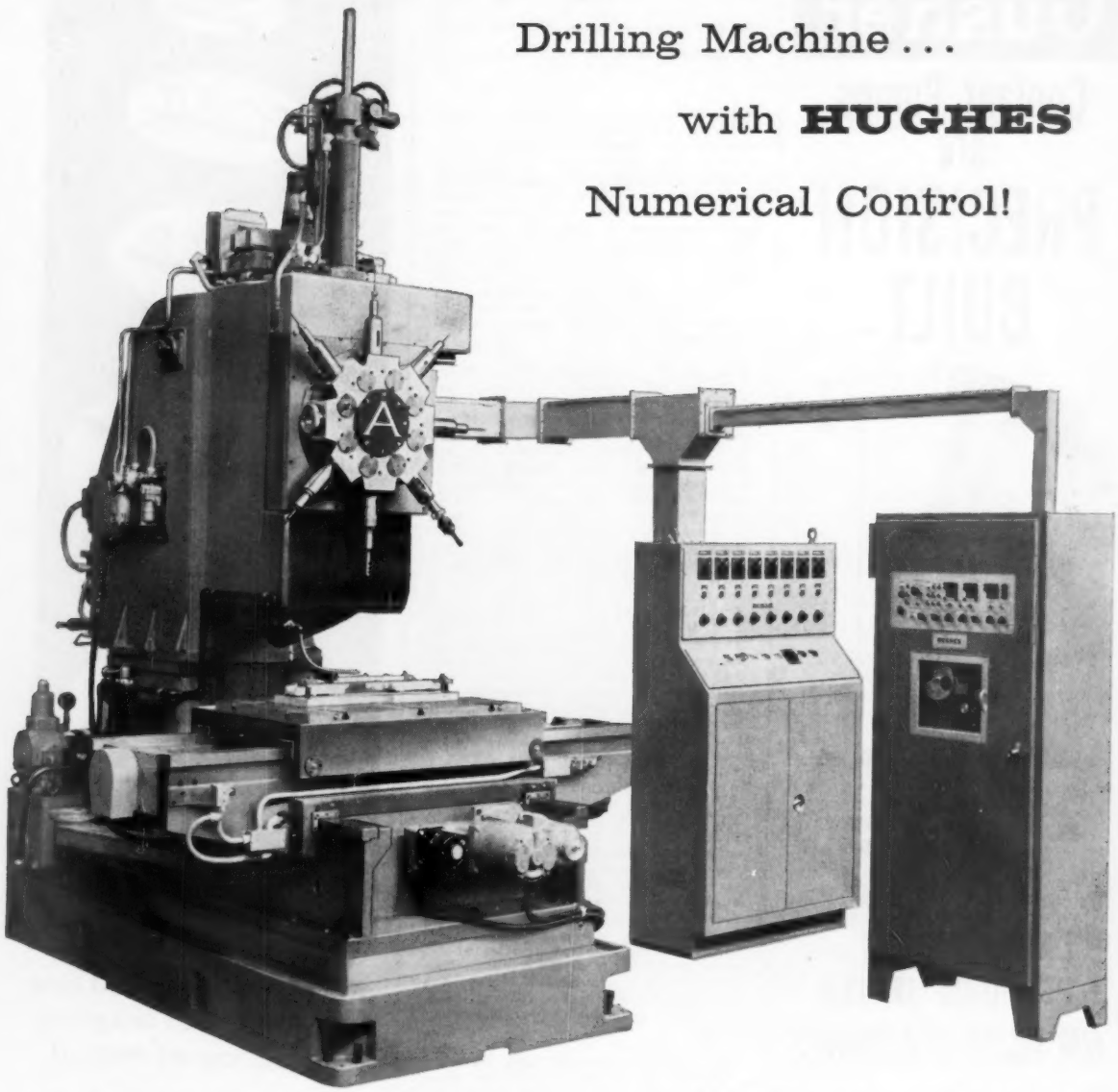
AVEY model no. 250 "Turret-Dex" Drilling Machine . . . with **HUGHES** Numerical Control!



- Three axes with 25″ x 35″ positioning table. Tape controlled feeds, speeds, reversing control for tapping plus tape creep feed of table for straight line milling 1¼″ drilling capacity.
- The HUGHES three axis Numerical Control system is fully transistorized for maximum reliability (Better than 95% "up" time). The System uses the most modern digital techniques for simplicity and reliability. Visual displays of input information are provided as standard equipment.

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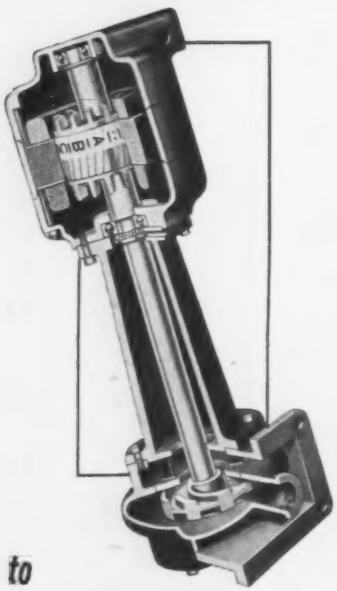

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11 TOOLING BALLS—*Industrial Tectonics Inc, Ball Division, 3684 Jackson Rd, Ann Arbor, Mich.* 6-page bulletin B-42 provides information on high-grade stainless steel tooling balls used in making and checking machining setups and assemblies such as jigs and fixtures where holes or surfaces must be accurately located at compounded angles or in two or more planes. Includes drawings showing how a tooling ball is used as a reference point in locating a hole; complete specifications on stock fixture balls and checking balls; special tooling balls; and typical application setups.

12 SOLID LUBRICATION — *Alpha-Molykote Corp, 65 Harvard Ave, Stamford, Conn.* 8-page bulletin 132 discusses the theory and use of solid lubricants. Describes such barriers to effective lubrication as galling and seizing, extreme pressures, high friction, chemical reaction, temperature and extreme environments, and tells how solid lubricants can overcome them. Properties of molybdenum disulfide as a dry-film lubricant, including chemical stability, electrical and magnetic properties, thermal stability, and coefficients of friction, are detailed.

13 PROFILOMETER — *Micrometrical Manufacturing Co, 3621 S State Rd, Ann Arbor, Mich.* 8-page bulletin describes the Profilometer and its conformity to the ASA Standard B46-1-1955. Topics covered include how to designate the characteristics of surface irregularities, how to measure the specified surface characteristics, and how the instrument is used to measure the average roughness height.

14 SOLUBLE CUTTING OILS—*Shell Oil Co, 50 W 50th St, New York 20, NY.* Technical bulletin is offered on Shell Dromus Oils and Shell Cool Oils, soluble cutting oils specially formulated for improved performance and higher production in metalworking operations. Eight soluble oils make up a series of cutting oils offering such advantages as superior lubrication between cutting tool and chip; increased life for cutting tools and grinding wheels; exceptional stability of the emulsion. Contains a guide to selection and dilution rates for specified machining operations on steels, irons, alloys, aluminum, copper, and copper metals.

15 CUTTER SHARPENING—*Rocheleau Tool & Die Co, Leominster, Mass.* 24-page catalog 604 covers attachments and accessories for cutter sharpening. An improved cutter grinding fixture and air-cushioned spindle bearing are featured. Many methods for sharpening cutting tools are described and illustrated.

HEAT TREATING AND WELDING

16 ELECTRIC INFRARED OVENS—*Radcor Inc, PO Box 422, Fostoria, Ohio.* 16-page catalog BRG-115 describes full line of standard temperature-rated units. Covers the Radcor temperature rating method of automatically providing the right oven answer to electric infrared heating problems, once total time and maximum temperature have been determined. Lists 540 vertical and 144 horizontal standard models and the price for each, including controls.

17 FLUIDIZED BEDS—*General Electric Co, Schenectady 5, NY.* 4-page bulletin GED-4306A describes GE's new heat processing tool, fluidized beds for annealing, normalizing, solutionizing, aging, hardening, quenching, and isothermal transforming. Advantages of the new process, including as much as an 85% reduction in

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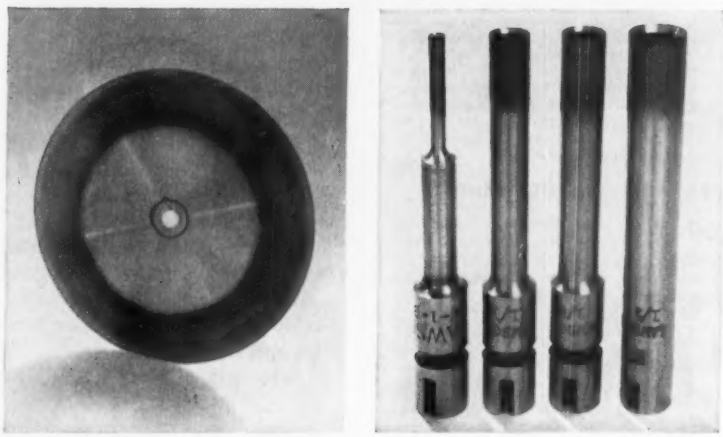
Linde Coatings & materials News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Long wear for precision cutting parts now comes in thin coatings —.001" thick



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Tungsten carbide coating enables serrated knives used in cutting plastic sheeting to process three times as much material before the first re-sharpening is necessary.

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Flame-Plating proved so revolutionary for household cutlery that the manufacturer built his merchandising theme around *"The Greatest Development in 2000 Years of Cutlery Making—a Cutting Edge of Tungsten Carbide."*

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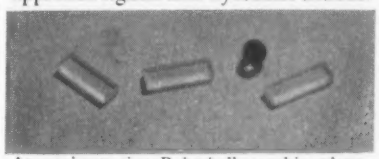

Approximate size: Ruby ball, sapphire plates.

A similar wear surface bears on the cam head. Certain fly wheel governors also have sapphire wear surfaces.

This 70,000 to 300,000 psi LINDE material has a hardness second only to diamond, unlubricated static friction coefficient of .18, and dynamic of .08 against itself in moderate loads. It is economically suited for wear applications such as gage points, textile guides, optical inspection flats, and flow valves. Send coupon for information.

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heating time, are discussed. Batch processing of small parts, a primary application, is described as well as other heat treatments requiring continuous movement of the work through the furnace. Ratings, dimensions, and performance data included.

18 FURNACES—*Lindberg Engineering Co, 2450 W Hubbard St, Chicago 12, Ill.* Illustrated bulletin 1094 details the capabilities of two box-type furnaces. Type GB6-6104-A is suited for a wide variety of applications where the use of non-combustible (inert) atmospheres are required. It provides a range of temperatures (up to 2500 F) in continuous operation. Type GB-55 with operating temperatures ranging up to 2750 F is designed for use in numerous toolroom, laboratory, and pilot-plant applications.

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19 DUST COLLECTORS—*John Wood Co, Air Pollution Control Division, Florham Park, NJ.* 4-page bulletin 230 pictures and describes functions and applications of self-contained cyclone separators, fabric filters, and combination fabric/cyclone separators in low-volume systems. Feature of this equipment is building block construction.

20 LIFT TRUCKS—*Allis-Chalmers Manufacturing Co, Engine-Material Handling Division, Milwaukee 1, Wis.* 24-page catalog BU-680 presents operating, engineering, and construction details on seven new F series units including three special FS models. Capacities range from 2000 to 10,000 lb.

PARTS AND MATERIALS

21 BALL BEARINGS—*Fafnir Bearing Co, New Britain, Conn.* 60-page catalog pictures and describes complete line of wide inner ring ball bearings that can be easily mounted on straight shafts and positioned without shoulders, locknuts, or adapters. Included is a complete line of power transmission units, such as pillow blocks, flange cartridges, cylindrical cartridges, and take-up units.

22 FASTENING PRODUCTS—*Albany Products Co, 351 Connecticut Ave, S Norwalk, Conn.* 32-page booklet lists, illustrates, and classifies full line. Includes over 25,000 different sizes, styles, and types in stainless steel, aluminum, brass, bronze, and Monel. More than 200 different basic types are pictured; more than 450 different AN and MS fasteners are classified.

23 CORROSION RESISTANCE OF STEELS AND ALLOYS — *Climax Molybdenum Co, 1270 Ave of the Americas, New York 20, NY.* 60-page booklet, "The Role of Molybdenum and Copper in Corrosion Resistant Steels and Alloys," containing tables, charts, graphs, and photos, describes in detail the rapid development during the 1950's of corrosion resistant steels based on the use of molybdenum, copper and nickel, together with sufficient chromium to retain, in large measure, the resistance to oxidation provided in the familiar chromium and the austenitic chromium-nickel (18-8) types of stainless steel.

24 CAMS AND CAMSHAFTS—*Eonic Inc, 464 E Hollywood, Detroit 3, Mich.* 6-page bulletin 210 covers a wide range of cams and camshafts. Face and cylindrical cams; two and three-dimensional cams; aircraft cams; master cams; hydraulic pump cams; cams for wrapping and packaging special machinery illustrated. ●

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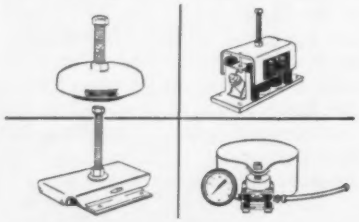

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We emphasize that Lodge & Shipley NUMERITURN Lathes are *not* modified engine lathes. Just as an example, the bed is entirely new, designed not only for strength and long-lasting accuracy but for efficiency as well. It provides the ultimate in guiding and positioning the carriage, full protection of the precision screw, and unobstructed chip disposal.

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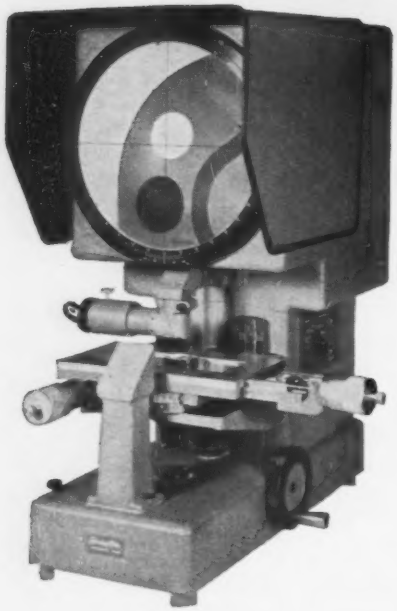

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TECHNIQUES OF VALUE ANALYSIS AND ENGINEERING — *By Lawrence D Miles. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, NY. 267 pages, 6 x 9 in. Price $8.50*

In July 1949 the first article ever written on Value Analysis appeared in this magazine. The author, Lawrence D Miles, described a new approach to product evaluation that he had developed at the General Electric Company.

That first article was a definitive outline of what has since become one of the most successful managerial tools of our times. Now the same author has written a book on the subject. The work must be considered *the* basic guidebook in the field of Value Analysis (or Value Engineering, as some prefer to call it).

Today Value Analysis is such a familiar term to readers of business magazines that no attempt will be made here to describe its basic principles. Those readers who do not know the subject are urged to use *Techniques of Value Analysis and Engineering* as a text. And those who have been practicing Value Analysis will find it an indispensable tool for training and for reorientation of their own programs.

Wisely, the author at the outset devotes a good deal of space to the philosophy of Value Analysis, which many practitioners have not always understood fully. For Value Analysis is not simply a cost-reduction tool that automatically produces huge savings. Rather, it is a formal discipline that includes step-by-step procedures for examining products. Any company that eliminates portions of the discipline, or simply pays lip service to it, is really not getting the most out of its Value Analysis program.

A wealth of material is in this book. The author carefully describes all the techniques that go into Value Analysis, how a company can use these techniques, and how to set up a working program. Scores of examples, with illustrations, show "before" and "after" products that have been analyzed for value. Supplementary chapters describe in detail such subjects as training for value analysis, the environment in which VA works best, and the effect that a program has on all elements of a business.

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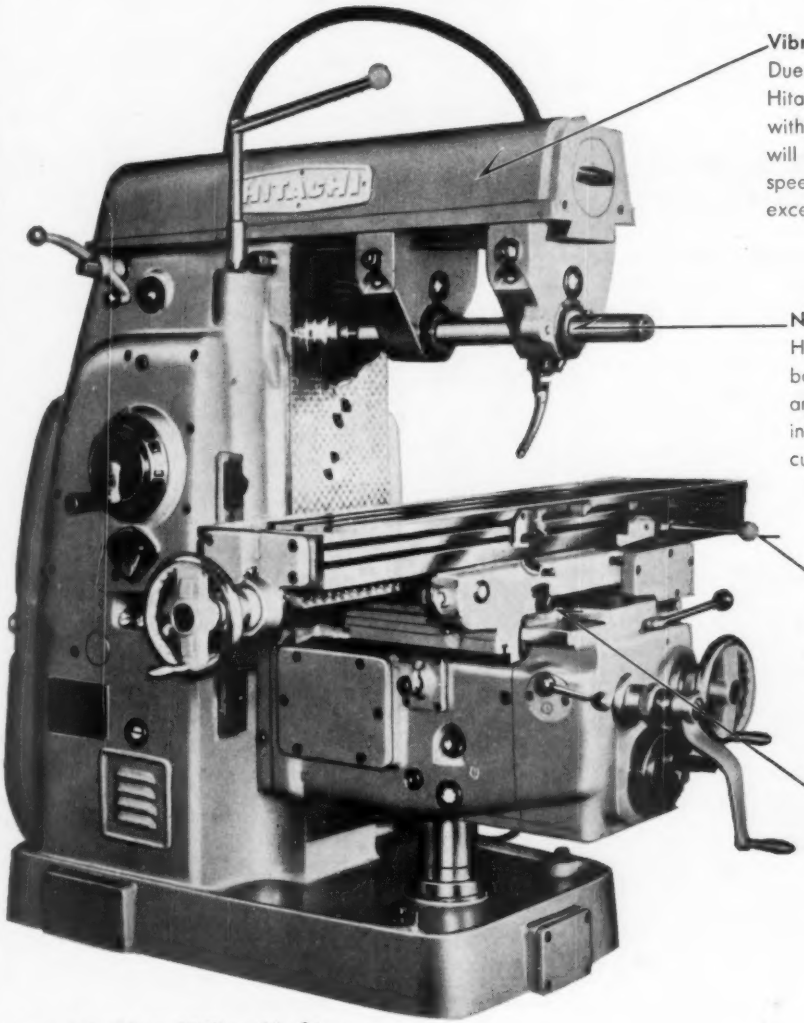

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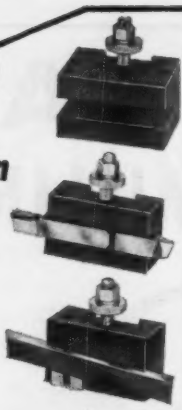

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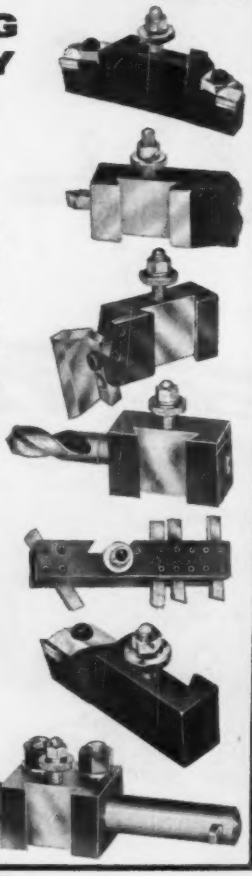

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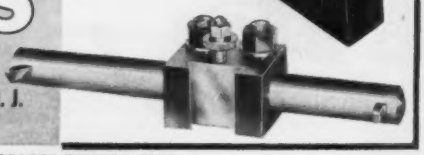

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just about all the information it needs to set up a Value Analysis program of its own. It is a tribute to the author that he has been able to put, into a limited space, so much detailed information on so broad a subject.—*TJ*

•

UNTERSUCHUNG DER URSACHEN FUR FORM- UND MASSFEHLER BEI DER FEINARBEITUNG. (*Investigation of the causes of errors in shape and dimension in fine machining). By Opitz and Brammertz. Published by Westdeutscher Verlag, Koln und Upladen, Germany. 44 p, 11¾ × 8¼. Paper back. Price 15.20 DM ($3.00). Printed in German.*

The authors discuss the attempts that have been made to smooth the ripples produced by a round-nose turning tool by using a large radius on the trailing edge of the tool. The height of the ridges to be removed by this secondary cutting edge is established by the feed per revolution and the radius of the tool.

The flanks of tools with secondary cutting edges wear rapidly and show many deep grooves. The causes of this wear are discussed in detail in this volume.

The secondary cutting edge must remove material that has been work hardened by the main cutting edge. Furthermore, there is a relationship between the radius of the cutting edge and the minimum chip thickness. Attempts to remove chips thinner than the minimum result in squeeze-wear.

If the feed per revolution is small compared to the tool radius, a triangle with curved sides near the bottom of the groove presents a chip thinner than the minimum, and squeeze-wear occurs. The geometry of this condition is investigated mathematically, and results are compared with experimental data. Charts show the minimum roughness attainable without undue wear.

The authors have collected all the information that is available in literature and supplemented bibliographical information by conclusions drawn therefrom, as well as from their own experimental work. Although much of the information has been known in mass-production machining, the studious compilation by the authors should be helpful. •

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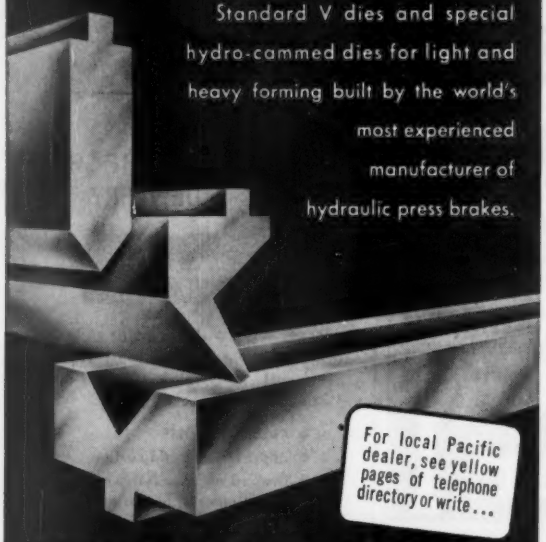

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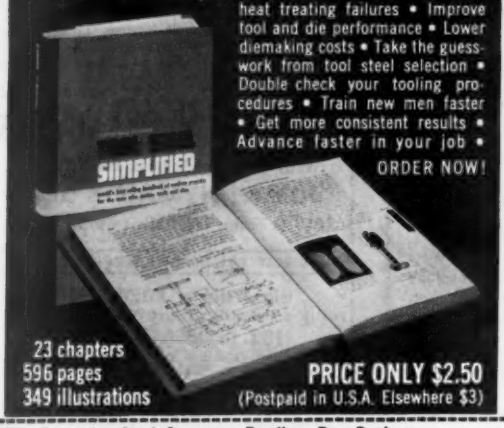

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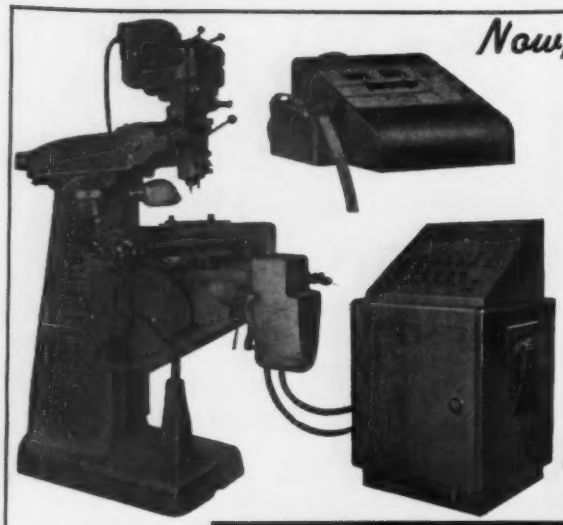

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*28" Columbia No. 4 MT. 3" cap. 10 HP

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*#12 Gleason Generator Dbl. Roll R & Finisher
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*Type A Barber Coleman Hobbers (1 long bed)
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*Type 6 Fellows #61 Shaper 35" OD Cap 1950

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*6 x 18 Landis Ext. w/Plunge #24473
*12 x 36 Cinc. Univ. w/Int. Spdl. RBG
**10x24 No. 4BG1 Van Norman 15" Head '55
**12x36 Landis Univ. Int Spdl (1950')
**30x48 Landis CHW Univ Like New 1952
*#2 Cinc. Centerless, Profile Dresser RBG
*16 x 36 Landis Cyl. w/5" Head
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**180 Sheffield, Multiform (1957) Like New

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**1310R Bryant Hole Face & Int. 28 Spdl (1952)
*109 Bryant Int. New Spdl. (1947) RBG
*72A3 Heald TR Mod. & Sizematic Mod.
*16-16 Bryant Chucking 1600 RPM
**#172 Heald 36" Swg. 36" Str. '45 & '50

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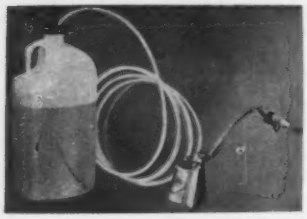

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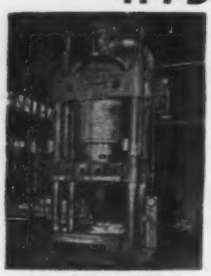

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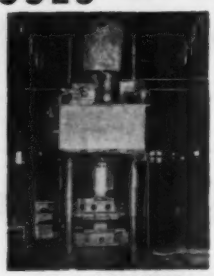

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10/30/61

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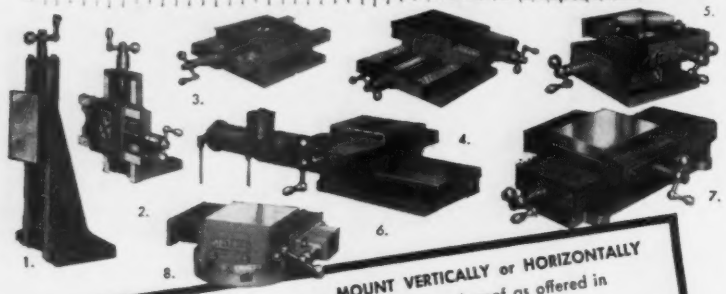

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American Machinist \ Metalworking Manufacturing

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MORE PRODUCTION + ACCURACY + PROFITS

LESS TOOLING — LEAD TIME — HUMAN ERROR

KNIGHT No. 65

NUMERICALLY CONTROLLED JIG BORER

3 TABLE SIZES

18" x 52" . . . . . Travel 28"
18" x 60" . . . . . Travel 36"
22" x 60" . . . . . Travel 36"
Cross travel . . . . 18"

VERTICAL CAPACITY

Min. 2½"; Max. 27½"
Throat . . . . . 18½"
WEIGHT—11,000 Lbs.

Automation unexcelled among precision boring machines! Accuracy is within tenths. Extremely rapid positioning by hydraulic cylinders with no back lash. Non-influencing clamping of table and saddle is automatic.

Positioning accuracy is positive with Sperry Control containing about half the components and simpler hydraulic system than other equipment. Measuring is done by ultra-precision linear transducers and pneumatic tape reader reducing all tape wear.

Rugged bed-type table on 3-way bearing—rigid mounting of spindle in precision ball bearings—hand-scraped bearing surfaces—plus many other features guarantee exceptional accuracy, speed and economy. *Ask For Complete Brochure.*

W. B. KNIGHT MACHINERY CO. 3920 WEST PINE BLVD. SAINT LOUIS, MO.

CIRCLE 377 READER SERVICE CARD

DO YOU HAVE THE ENGINEER'S GUIDE TO BLIND RIVETING PRACTICES?

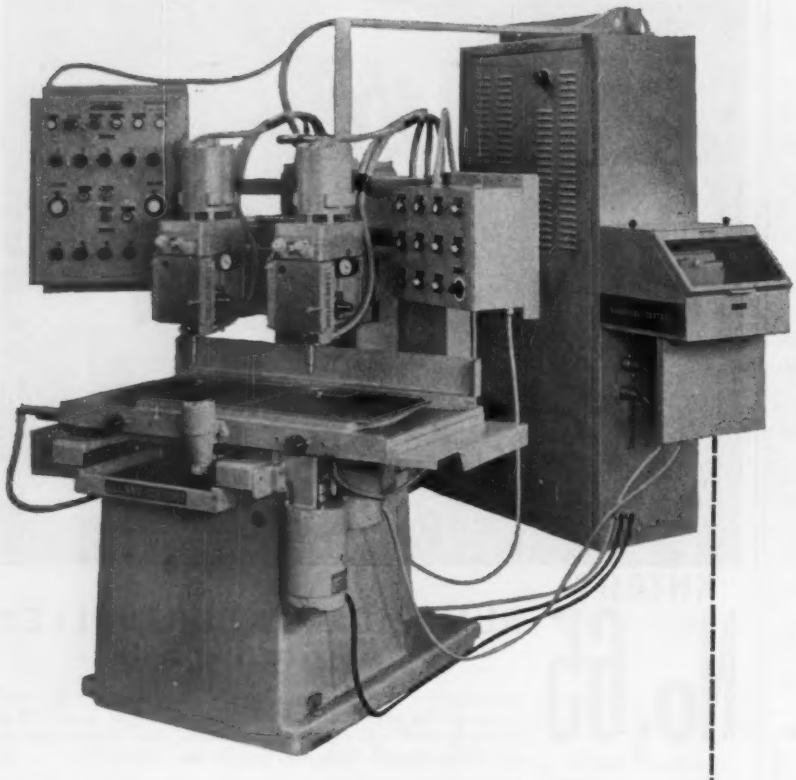
Installed cost of a blind rivet is ofttimes lower than over fastening devices. Here is a 8-page analysis and compendium of blind riveting practices and applications. The reprint is priced at 35¢ and may be secured from

Reader Service Department
American Machinist/Metalworking Manufacturing
330 West 42nd Street, New York 36, N. Y.

LELAND GIFFORD

PRINTED CIRCUIT BOARD DRILLING MACHINE

Operates in excess of 50 hits per spindle per minute — May be programmed by Flexowriter or direct from Art Work or Sample Board.



FEATURES

- Programmed by Flexowriter or direct from art work or sample board.
- Table position and spindle cycle actuated by G. E. Mark II Numerical Control with fast tape reader.
- Operates in excess of 50 hits per spindle per minute.
- Drills single boards or stacks.
- Up to four adjustably mounted, self-contained, hydraulic feed drilling units can be used.
- Table traversed hydraulically on ball-bearing mounted and guided round ways.
- High speed positioning by self-contained, closed loop, hydraulic circuits and reversible G. E. Thy-Mo-Trol controlled motor driven pump.
- Nation-wide control service available from General Electric Co.

Here is a practical, economical solution to the problems of fast, accurate production of electronic printed circuit boards. Combines the best features of the proven Leland-Gifford HOLE LOCATOR and the universally accepted modified G. E. Mark II numerical positioning control.

Hole patterns can be programmed by Flexowriter or directly from art work or sample board. Table can also be positioned numerically with control dials.

Up to four self-contained hydraulic feed drilling units can be employed, adjustably mounted on cross rail, to drill in excess of 50 hits per minute per spindle.

Write for detailed information and proposal — or ask to have an experienced sales engineer call.

SPECIFICATIONS*

Positioning accuracy	±.001″ non-accumulative
Repeatability	±.0005″
Table size	to suit requirements
Table travel	Standard 11″ x 15″ Optional 19″ x 15″
Overhang	14″, Optional up to 22″
Spindle nose to table	Maximum 10″ Minimum 0
Available stroke	up to 4⅜″
Feed rate	infinitely adjustable
Geared spindle speeds	500 Minimum to 7500 Maximum or 1000 Minimum to 15,000 Maximum
Floor space required	Machine 60″ x 50″ Control cabinet 94″ x 47″

**Subject to change. Dimensions are approximate.*

LELAND-GIFFORD
WORCESTER 1, MASSACHUSETTS

MORE METALWORKING FACTS FREE!

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How many employees in your plant?

1 ☐ Under 20
3 ☐ 20-49
4 ☐ 50-99
5 ☐ 100-249
6 ☐ 250-499
7 ☐ 500-999
8 ☐ 1000 and Over

What is major product manufactured at your plant?

_____

_____

_____

Please enter my personal subscription for **AM/MM**

USA only	1 Year $3.00 ☐	2 years $5.00 ☐	
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New subscription ☐ *Renewal* ☐

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October 30, 1961

AM/MM

(This card expires December 29, 1961)

FIRST CLASS
PERMIT
No. 64
(Sec. 34.9 P. L. & R.)
New York, N. Y.

BUSINESS REPLY MAIL
No Postage Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY

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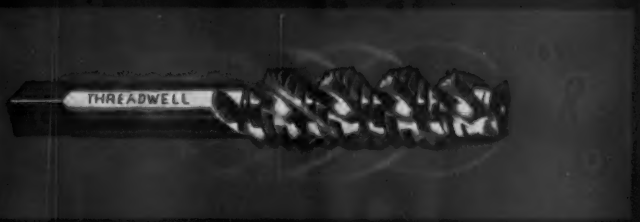
P.O. BOX 613

RIDGEFIELD, CONNECTICUT

CIRCLE 252 READER SERVICE CARD →

Only TURBO-CUT by Threadwell has a full 3-4 thread plug chamfer!



Benefit? Turbo-Cut's longer chamfer distributes the load over more teeth and breaks up chips to minimize tap breakage. Turbo-Cut's longer chamfer makes tapping easier and cleaner on through holes, does a one-pass job on blind holes. Only Threadwell makes the genuine Turbo-Cut with the longer chamfer.
Also available in
bottoming chamfer.

Threadwell
MAKES THE BEST PRODUCT BETTER

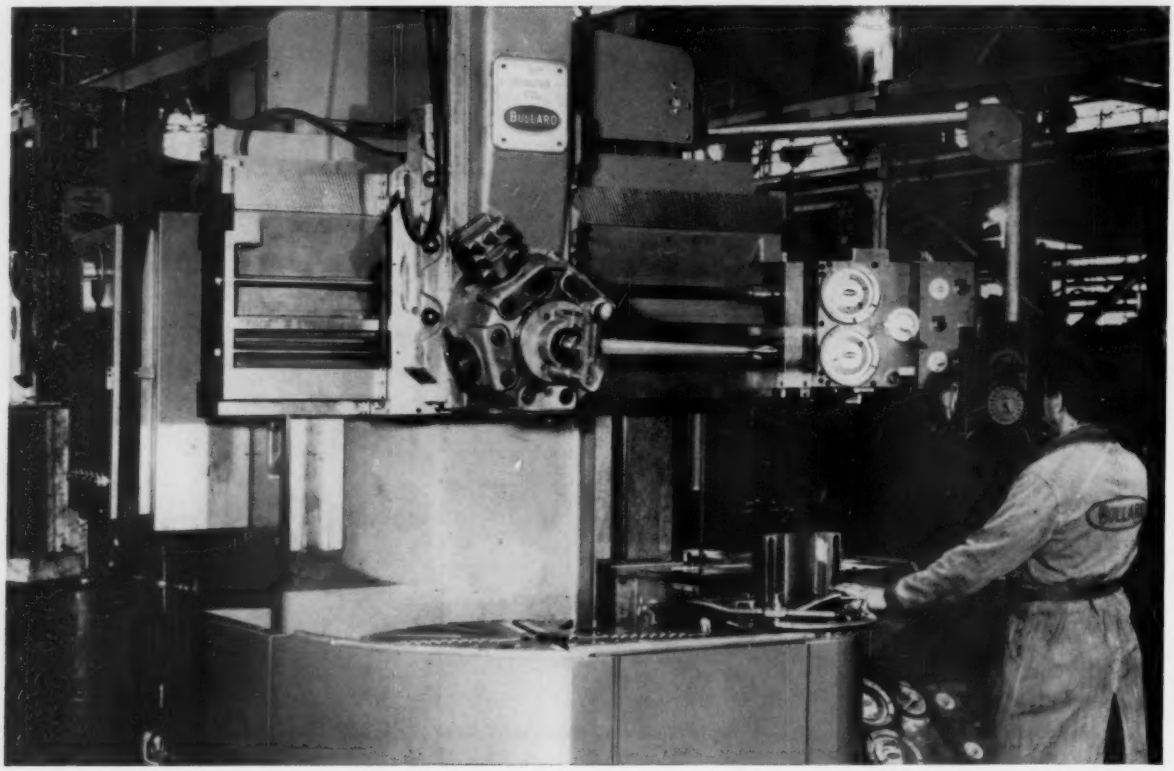
INDUSTRIAL DISTRIBUTORS
SERVING INDUSTRY ECONOMICALLY
THE RIGHT HAND OF PRODUCTION

THREADWELL TAP & DIE CO.
GREENFIELD, MASSACHUSETTS

Stocking Warehouses: New York — Cleveland
Detroit — Los Angeles — Greenfield, Mass.

New Bullard V.T.L. fully powered for high production:

Has Timken® bearings for high precision



The first fully-powered vertical turret lathe, this Bullard Dynatrol® is designed to increase machine speed and output. Dynatrol provides single lever or remote control of all head motions, traverse and feed engagement. To assure precision, Bullard uses Timken® tapered roller bearings at vital points—table radial position, headstock, clutch shaft, input pulley, rail raising bracket. Their taper lets Timken bearings take *any* combination of radial and thrust loads. In the headstock, for example, Timken bearings hold shafts in proper position for smooth gear mesh and power transmission. And precision manufacture of Timken tapered roller bearings assures high precision in the machine.

ENGINEERING SERVICE THAT SAVES YOU TIME AND MONEY. Working with you at the design stage, our sales engineers can often solve your bearing problems on the spot. From the wide range of Timken bearing sizes, types and precisions they can help you select the Timken bearings to give you the maximum in efficient, economical design engineering.

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.

CIRCLE 253 READER SERVICE CARD